A.M.A.

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EXTRAPERITONEAL PNEUMOGRAPHY IN DIAGNOSIS OF RETROPERITONEAL TUMORS — HOWARD L. STEINBACH, M.D., et al.

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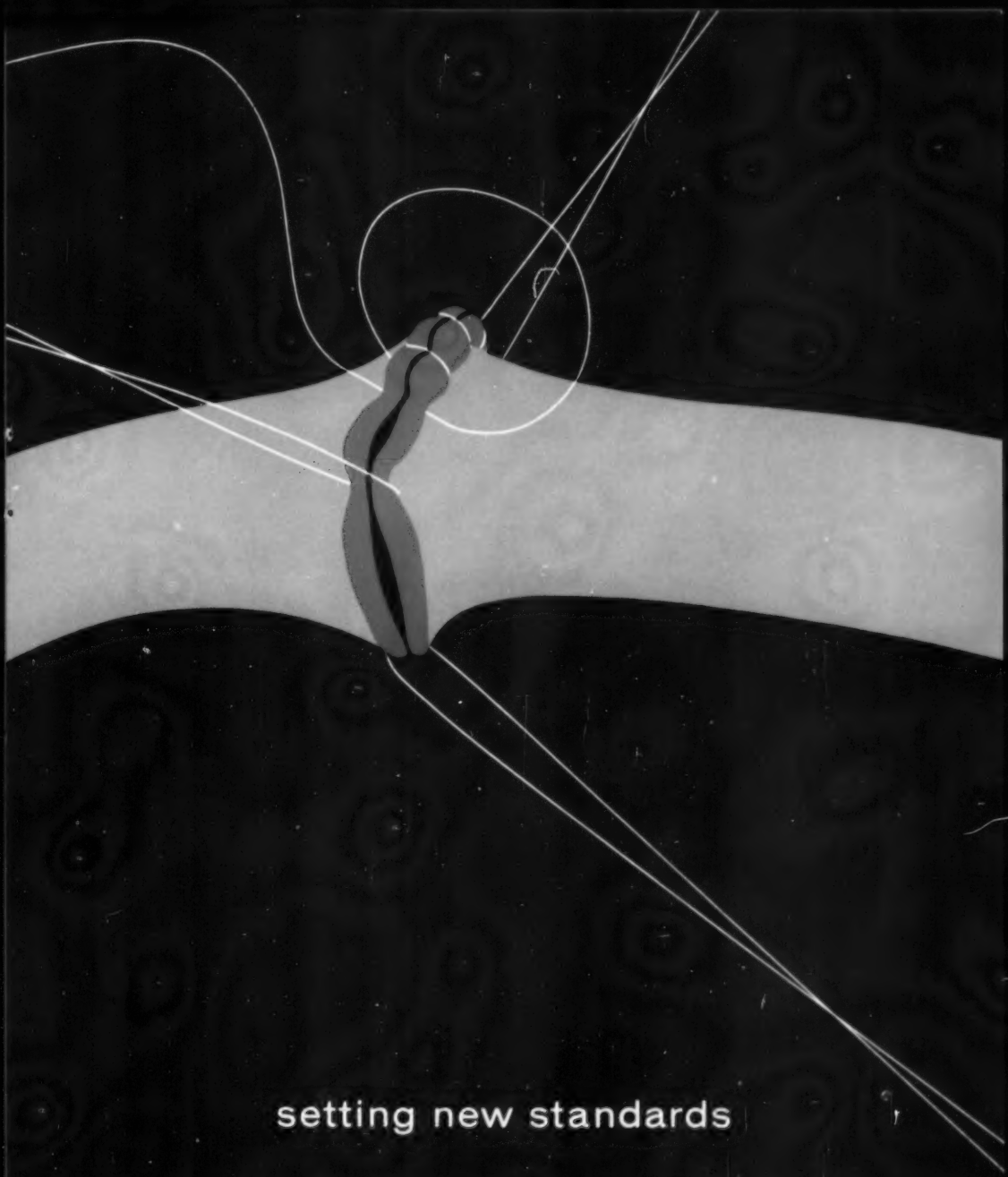

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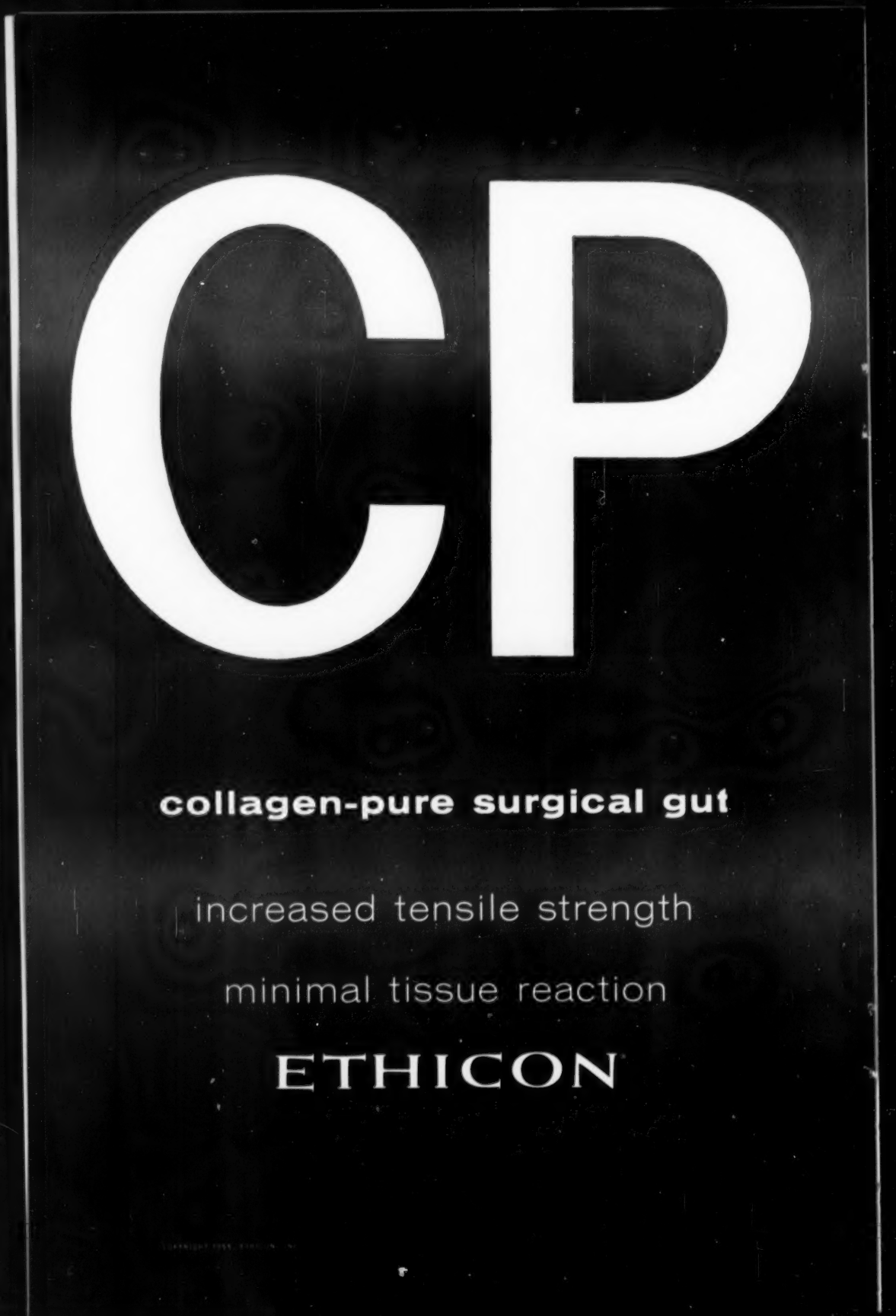
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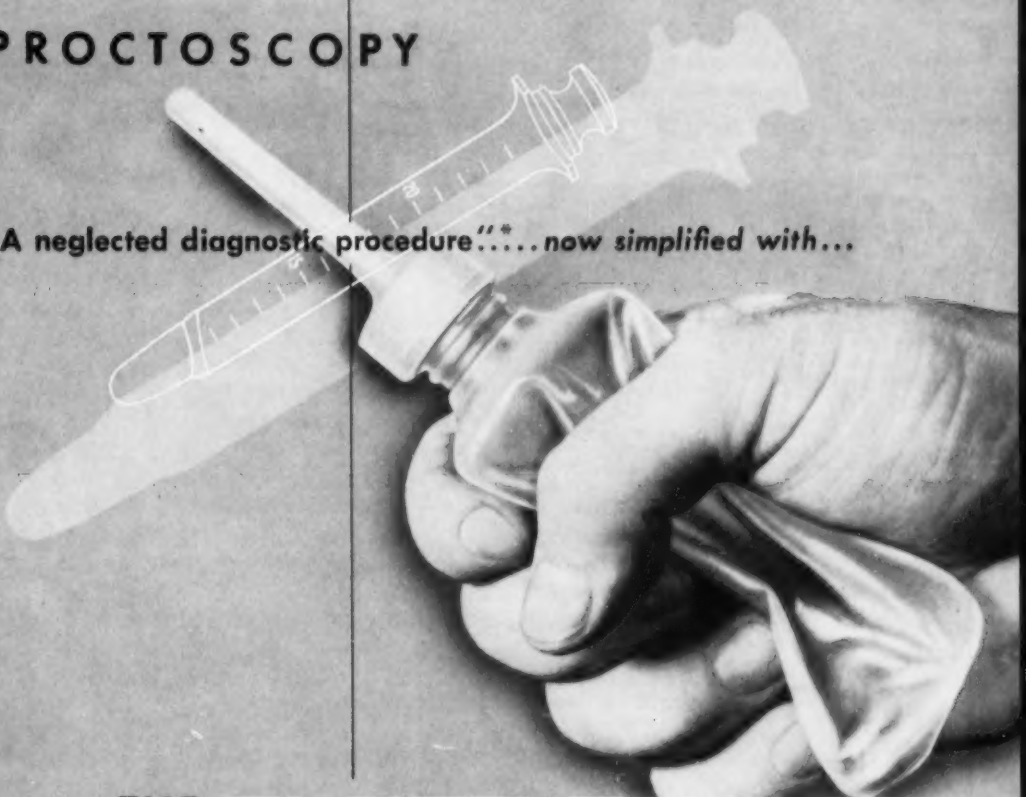

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1. Parsons, W. H., et al.: Ann. Surg. 135:791 (June) 1952. 2. Whiting, J. A., and Hotz, R.: Surg., Gynec. & Obst. 97:709 (Dec.) 1953. 3. Beling, C. A., et al.: Geriatrics 7:179 (May-June) 1952. 4. Barbour, C. M., Jr., and Tennant, R.: J. Urol. 71:497 (April) 1954.

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Editorials

DR. OCHSNER, MEMBER OF EDITORIAL BOARD, HONORED

It is with particular pleasure that the members of the Editorial Board of the A. M. A. Archives of Surgery note the selection of one of its long-time members, Dr. Alton Ochsner, William Henderson Professor of Surgery and Chairman of the Department of Surgery in the Tulane University of Louisiana School of Medicine, New Orleans, as one of the recipients of the 1955 Modern Medicine Award for Distinguished Achievement.

The award was presented to Dr. Ochsner "for his work in the surgical treatment of cancer and the stimulus he has given to all research in the field of cancer." Recipients of the awards are chosen from candidates nominated by physicians throughout the United States.

Dr. Ochsner is president of the International Society of Angiology and has been president of many surgical societies, including the American College of Surgeons.

In 1935, Dr. Ochsner was appointed to the Editorial Board of the *Archives of Surgery* and since that time he has been reappointed repeatedly because of his excellent editorial work and forward-looking ideas for surgical publications. These qualities have made him a valued member also of the editorial boards of *Surgery* and the twelve-volume Lewis' "Practice of Surgery." His interests and attributes have accounted, moreover, for his successful chairmanship of the Editorial Board of the *International Abstract of Surgery*. It is with much pleasure that the members of the Editorial Board of the A. M. A. Archives of Surgery congratulate Dr. Ochsner on his many achievements in surgery and on his generally recognized good citizenship, the latter attested by his being chosen as the "Leading Citizen of New Orleans" on one occasion and as one of the kings of the Mardi Gras on another.

Waltman Walters, M.D.

CLASSIFICATION OF RETROPERITONEAL TUMORS AS A GUIDE IN CLINICAL DIAGNOSIS

WILLIAM J. ENGEL, M.D., Cleveland

THIS SYMPOSIUM on retroperitoneal tumors concerns itself with the clinical aspects of diagnosis and treatment. The classification to be presented has been designed as an aid to the clinician who is called upon to make an identification of a questionable tumor. The term tumor will be used in the broad sense of any morbid enlargement or swelling, and, while pathologic types are included, no attempt is made to include all the many histopathologic types of tumors which have been reported in the literature.

For the clinician, retroperitoneal tumors must include all tumors occurring in the retroperitoneal space. This space is bounded by the diaphragm above and the brim of the true pelvis below, and it lies between the posterior peritoneum in front and the muscles of the abdominal wall behind. Many cases of these tumors are first brought to the physician's attention because of a palpable mass in the abdomen. It is probably safe to estimate that 75 to 80 per cent of all these tumors will be palpable on careful examination, and the palpable abdominal mass is always a diagnostic challenge. No age is exempt, for these tumors may be encountered in newborn infants through all ages to the senile person.

CLASSIFICATION

All retroperitoneal tumors fall into one of three broad categories: (1) primary unattached tumors, (2) tumors arising in organs normally present in the retroperitoneal space, and (3) primary or metastatic tumors involving the retroperitoneal lymph nodes. To classify any given tumor clinically into one of these three groups requires x-ray study particularly by means of intravenous or retrograde pyelography, and often other special methods, to be discussed in this symposium, will supply valuable information. Frequently it is possible to separate these tumors only into one of these three broad groups. However some of the subgroups may be correctly identified, and, in order to present the various possibilities which must be considered, the following classification is offered as a guide for the clinician and radiologist.

I. Primary Unattached Tumors
  A. Benign
    1. Lipoma
    2. Dermoid
    3. Fibroma
      a. Cystic fibroma
    4. Serous cystadenoma
    5. Epithelial cysts
    6. Lymphangioma
  B. Malignant
    1. Sarcoma
      a. Fibrosarcoma
      b. Leiomyosarcoma
      c. Liposarcoma
    2. Adenocarcinoma
    3. Embryoma
    4. Chorioepithelioma
    5. Carcinoma in aberrant adrenal tissue
    6. Undifferentiated neoplasms

II. Tumors Arising from Organs in the Retroperitoneal Space
  A. From Kidney
    1. Benign lesions
      a. Neoplasms
        (1) Adenoma
          (*a*) Renal cell
          (*b*) Papillary
          (*c*) Fibroadenoma
        (2) Hamartoma

From the Department of Urology, The Cleveland Clinic Foundation, and The Frank E. Bunts Educational Institute, Cleveland.

Read in the Symposium on Retroperitoneal Tumors before the Joint Meeting of the Section on Radiology and the Section on Urology at the 103rd Annual Meeting of the American Medical Association, June 23, 1954.

- b. Congenital or developmental
  - (1) Serous cysts—single or multiple
  - (2) Polycystic kidneys
  - (3) Hydronephrosis from congenital ureteropelvic obstructions
- c. Inflammatory masses
  - (1) Pyonephrosis (often with calculi)
  - (2) Cortical abscess
  - (3) Perinephritic abscess
- d. Traumatic
  - (1) Subcapsular or perinephritic hemorrhage
  - (2) Encysted hematoma (may be calcified)

2. Malignant neoplasms
- a. Renal cell carcinoma
  - (1) Clear cell (hypernephroma)
  - (2) Granular cell
  - (3) Tubular carcinoma
  - (4) Mixed types
- b. Sarcoma
  - (1) Fibrosarcoma
  - (2) Liposarcoma
  - (3) Leiomyosarcoma
  - (4) Osteosarcoma
- c. Mixed tumors
  - (1) Embryoma (Wilms tumors in children)
- d. Tumors of renal pelvis (rarely palpable masses)
  - (1) Transitional cell
  - (2) Squamous cell

B. From Adrenal
1. Medullary tumors
- a. Neuroblastoma
- b. Pheochromocytoma
  - (1) Benign
  - (2) Malignant

2. Cortical tumors (may be functioning or nonfunctioning
- a. Adenoma
- b. Carcinoma

C. From Pancreas
1. Cysts
2. Solid tumors (carcinoma)

III. Tumors in Retroperitoneal Lymph Nodes
A. Primary Tumors
1. Lymphosarcoma
2. Lymphocytic leukemia
3. Giant follicle lymphoma
4. Reticulum cell sarcoma
5. Hodgkin's disease

B. Metastatic Tumors
1. From testicle
2. From ovary
3. From intraperitoneal organs

I. Primary Unattached Tumors.—These retroperitoneal tumors, once considered rare, have been reported in such numbers that they can no longer be so regarded. They may be benign or malignant; solid, cystic, or both; single or multiple, and of varied histologic type. Recurrence following surgical removal is common, and a tumor originally regarded as benign may recur as a malignant tumor.

Hansmann and Budd [1] studied a group of these tumors and came to the conclusion that they arose chiefly from embryological remnants of the urogenital tract. They based this conclusion upon the varied histologic types and the fact that so many of these tumors resemble tumors encountered in adult urogenital organs. This concept has received general acceptance.

Tumors may also arise from adult tissue normally present in the retroperitoneal space, notably fibrous connective tissue, fat, nerves, and ganglia, as well as from blood vessels or lymphatics.

II. Tumors Arising from Organs Normally Present in the Retroperitoneal Space.—A. From Kidney: Kidney tumors of various types constitute the largest group of retroperitoneal tumors. Benign adenomas are frequently rather small and of no clinical importance. However, they may grow rather large and produce a palpable mass as well as a well-marked pyelographic deformity. Histologically they may be renal cell, papillary, or fibroadenoma. There is some evidence that these adenomas may undergo malignant change and be the forerunner of such tumors as the hypernephroma (clear cell carcinoma).

The commonest benign tumor of the kidney is the serous cyst. Commonly seen at the lower pole of the kidney it is by no means limited to this area. It may occur at the upper pole, in the mid-portion, or in the parapelvic area. They may be single or multiple and Gibson [2] has recently called attention again to the fact they may be associated with a malignant tumor of the kidney.

Polycystic disease of the kidneys is always bilateral although the extent of involvement

is not always symmetrical. It is a familial disease and the most common cause of bilateral renal masses.

Hydronephrosis due to congenital or other obstructive ureteropelvic lesions may produce a palpable tumor. This may occur at any age and must be particularly borne in mind in children where it may mistakenly be considered as a Wilms tumor.

Inflammatory masses of renal origin must be included in a classification of retroperitoneal tumors. A large pyonephrosis may be the result of infection in a pre-existing hydronephrosis, is frequently associated with infection occurring with a large coral-type renal calculus, and I have encountered it several times as the result of long-standing renal tuberculosis. Cortical abscess, which may be single or multiple, often produces a palpable abdominal mass, and perinephritic abscess is well known for its characteristic mass with fullness or bulging in the costomuscular angle. The diagnosis of these inflammatory lesions is, of course, generally aided by other clinical features of the illness. However, it may not be amiss to remind ourselves that a degenerating renal cancer may produce the clinical picture generally associated with infection.

The commonest traumatic lesion to produce a mass is a hematoma. This is usually the result of a ruptured kidney and may be subcapsular or perinephritic. Spontaneous perirenal hemorrhage has also been reported. We have seen one patient with a large encysted retroperitoneal hematoma resulting from a ruptured spleen. Old encysted hematomas may become calcified, leading to a mistaken diagnosis of neoplasm. In rare instances a hematoma may be present without a clear-cut history of specific injury, as in a case we have encountered in a young football player.

Of the malignant tumors of the kidney the type most frequently encountered is the hypernephroma, or clear cell carcinoma. It often produces a palpable mass, although it is usually hematuria which brings these patients to medical attention. The granular cell and tubular carcinoma are less common and generally more malignant, since they are free-growing nonencapsulated tumors.

Sarcoma of the kidney of any type must be regarded as a rarity. However the ones we have seen have produced a palpable mass in the flank, and they must be considered in any complete classification of renal tumors.

The commonest mixed tumor, or embryoma, of the kidney is the Wilms tumor of children. It should always be considered first when a palpable tumor is found in a child. This type constituted 53.4% of all retroperitoneal tumors in children reported by Snyder and co-workers.[3] It is a very malignant tumor, and the long-term prognosis with any treatment is extremely grave.

Tumors of the renal pelvis (included for completeness) rarely produce a palpable mass unless late and with extension outside the kidney. Thus a palpable mass with a tumor of the renal pelvis is a bad prognostic sign. They are either papillary transitional cell tumors or squamous cell carcinoma. The latter have a particularly unfavorable prognosis and in the 7 cases reported from our clinic by Higgins [4] only one survived more than 3 years and he eventually died with extensive metastasis.

B. From Adrenal: Tumors of the adrenal are logically divided into those which arise from (1) the medulla and (2) the cortex.

The adrenal medulla develops from cells which migrate from the neural canal, and tumors that arise from it are therefore nerve-type tumors. The neuroblastoma is not an uncommon tumor and occurs chiefly in childhood. It is a malignant tumor and usually manifests itself by a palpable mass in the abdomen, although not infrequently patients with such a tumor first come to medical attention with metastases, especially to bone. Roentgenographically some 50% of these tumors will show a characteristic stippled calcification on the plain film and all will show some degree of renal displacement when pyelography is carried out by either the intravenous or the retrograde route. The prognosis is very poor, even though surgical

removal of the tumor is possible in many instances. The ganglioneuroma, a rare medullary tumor composed of ganglion cells, is not included in the classification.

The chromaffin cells are differentiated from the terminal sympathetic neuron cell. Tumors derived from these cells, termed pheochromocytomas, are functioning tumors and are of particular clinical significance because of the role they play in the production of hypertension. They rarely, if ever, reach the size to become palpable tumors, but they may be multiple and may occur in aberrant locations. They may be benign or malignant. The diagnosis is usually indicated by clinical examination and special laboratory tests. A clue is frequently presented by a soft tissue mass or renal displacement observed on the urogram films. It is in these cases that we have derived considerable assistance from retroperitoneal air contrast study, and my associate Dr. Poutasse identified correctly a bilateral pheochromocytoma in one patient by this method. We have favored presacral oxygen injection, which will be further discussed in this symposium.

The adrenal cortex is derived from the mesoderm of the Wolffian ridge, as are also the testes and ovaries. Benign adenoma of the cortex may be small and of no clinical importance. Larger tumors occur, however, and are usually functioning tumors. They should always be suspected with adrenogenital syndrome or Cushing's disease. It should be mentioned, however, that both of these disorders may occur in the absence of tumor, but associated with hyperfunction and hyperplasia of the adrenal cortex.

Carcinoma of the adrenal cortex may also be functioning or nonfunctioning. It may grow to a very large size without producing clinical symptoms until a mass appears. In one of our patients a tumor weighing 1,200 gm. was removed which had given no clinical signs until a bout of right-flank pain brought to attention a large palpable mass. This is a malignant tumor; recurrence and metastases are common, and the prognosis is accordingly poor.

The pancreas is a retroperitoneal organ, and tumors involving this gland often appear in the retroperitoneal space. They may be cystic or solid tumors, such as adenocarcinoma. Tumors of the tail of the pancreas are especially likely to appear on the left side and may displace the kidney or ureter. I can recall no instance in which a pancreatic tumor caused displacement of the right kidney or ureter. In fact, even those which originate in the tail of the pancreas have a tendency to enlarge anteriorly and renal displacement may not occur. In a series of 72 proved cases of pancreatic tumor reported by Shulte and Emmett,[5] 68, or 94%, did not show any renal displacement on the urogram films. I have seen one patient with an invasive carcinoma of the pancreas which so filled the left retroperitoneal space that no gas would enter when presacral oxygen study was done. Further observation may make this a diagnostic point of some significance.

III. Tumors in Retroperitoneal Lymph Nodes.—As a cause of retroperitoneal tumor mass, primary tumors of lymph nodes are uncommon, and it is even rarer for them to appear clinically and remain localized to the retroperitoneal nodes. More commonly the disease involves all lymph nodes. However, involvement of the retroperitoneal nodes may dominate the clinical picture. These tumors may be of any of the types indicated in the classification.

Metastatic tumors in the retroperitoneal or para-aortic lymph nodes are commoner. These nodes communicate with the mesenteric nodes, thus permitting intraperitoneal cancer to spread to this region. The upper lymph nodes of the para-aortic chain form a concentrated group located in the region of the root of the splenic and renal arteries. As pointed out by Desjardins,[6] this group of nodes receives lymphatic channels directly from the testes and ovaries. These nodes may in this manner be the first location of metastases from malignant tumors in these organs. When these para-aortic nodes become extensively involved, they produce ureteral tortuosity and even outward renal

displacement which may be demonstrated by pyelographic examination. Not uncommonly retroperitoneal lymph node involvement, either primary or metastatic, may be sufficiently massive to produce a palpable abdominal mass.

SUMMARY

A classification of retroperitoneal tumors is offered which is designed primarily as an aid in clinical diagnosis.

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EXTRAPERITONEAL PNEUMOGRAPHY IN DIAGNOSIS OF RETROPERITONEAL TUMORS

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SINCE the introduction of "retropneumoperitoneum" as a diagnostic roentgenologic procedure by Ruiz Rivas in 1947, this technique has found immediate international acceptance.* In many countries, articles have been written describing the usefulness of the technique, but very little has been said about its limitations in the diagnosis of the various types of lesions that are demonstrated. All authors agree that the procedure is relatively harmless. The possibility of producing an air embolus has been recognized, and at least one case of a nonfatal air embolus has been reported.

This report is an attempt to evaluate some of these considerations and to formulate certain criteria that would be useful in the diagnosis of retroperitoneal tumors. The technique used in injecting the gas into the extraperitoneal tissues has been described in detail in previous publications and will not be repeated here. Briefly, it consists of injecting a gas, preferably oxygen, into the areolar tissue between the rectum and sacrum and allowing the gas to spread throughout the extraperitoneal tissue. Subsequent roentgenograms demonstrate the organs lying within the gas-filled areolar tissue.†

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Read in the Symposium on Retroperitoneal Tumors before the Joint Meeting of the Section on Radiology and the Section on Urology at the 103rd Annual Meeting of the American Medical Association, June 23, 1954.

* References 1 to 7; 9 to 11; 13; 15 to 31; Ruiz Rivas, M.: Paper Read to the Royal Academy of Medicine, Madrid, June, 1947, and Paper Read to the Spanish Academy of Medico-Surgery, May, 1947; references 19 and 20.

NORMAL ADRENAL

Extraperitoneal pneumography probably has its greatest usefulness in the examination of the adrenal glands. These organs can sometimes be identified on plain roentgenograms because of the fatty capsule surrounding them, but they are usually not outlined with sufficient clarity to be of diagnostic value. The loose fascial sheath, known as "Gerota's fascia," which encloses the adrenal glands along with the kidneys and a considerable amount of fatty areolar tissue, has prerenal and retrorenal layers which are fused superiorly and laterally but open medially and inferiorly. The kidneys are freely movable within the fascial sheath, but the adrenal glands are more firmly attached to its apex. This fact can be used to advantage on the roentgen examination in cases in which the shadows of the adrenal and kidney are superimposed by obtaining roentgenograms with the patient erect, allowing the kidney to descend. There is normally a difference in the form of the two adrenal glands due to the molding of adjacent structures. The right gland is triangular; the left is semilunar and extends down the medial side of the kidney.

The injected gas passes through the defect in the inferior surface of the fascia and spreads through the areolar tissue to outline the kidneys and adrenals. Within this areolar tissue are numerous fibers linking the external renal surface to the internal surface of the perirenal fascia and the superior pole of the kidney to the inferior surface of the adrenal. On the roentgenograms the fibers are visible as reticulated strands. Occasion-

† References 25, 27 and 28.

Fig. 1.—Normal extraperitoneal pneumograms. The right adrenal is triangular and the left semilunar.

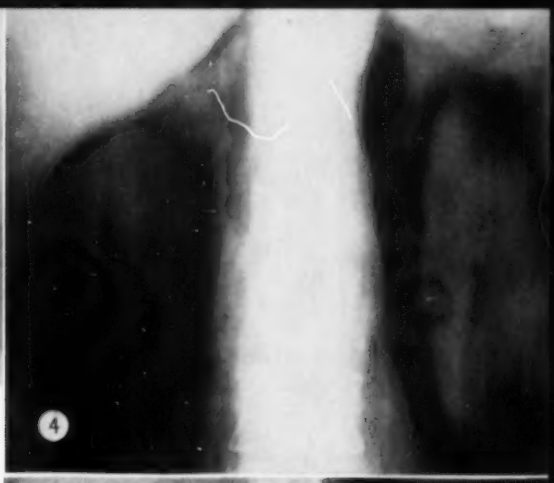
ally the attachment between the adrenal and the kidney is so firm that the gas cannot penetrate between them. In these instances the two appear as a single shadow. Sometimes the fatty capsule surrounding the adrenal is thick and presents a markedly reticulated, irregular shadow on the roentgenogram, which makes evaluation of the adrenal size difficult or impossible. This is particularly true of obese patients, and it is frequently encountered in patients with Cushing's disease.

The gas passes outside of Gerota's fascia, in addition to being present within it, so that it is visible as a paper-thin membrane surrounding the kidney and adrenal (Fig. 1). It is best demonstrated, with the aid of tomograms, along the lateral surface of these organs (Fig. 2). This structure has become of great importance in differentiating masses of adrenal or renal origin which lie within the fascia from tumors and cysts of adjacent organs, such as the liver, pancreas, spleen, and mesentery.

Because it is difficult to estimate the size of the adrenal, a method was sought to provide a quantitative value that could provide some idea as to the variations in their size which are encountered normally and as a result of disease. Since the roentgenograms depict only one plane of the organ, it was necessary to be content with measurements of the area as seen on an anteroposterior film. It was realized that this was not completely accurate, since there is a considerable variation in the ratio between the cross-sectional area and depth in the adrenals of different patients, but it did provide some frame of reference by which the glands may be compared. In many cases the outline of the gland was not sharply delineated, and it was necessary to reconstruct the margins as anticipated from the general shape of the gland; this also introduced a source of error. Nevertheless, a range of normal values was obtained which correspond fairly well and were, in general, different from the values obtained in patients with adrenals known to be enlarged or decreased in size.

To measure the area, a compensating polarimeter was employed. The same results could be obtained by tracing the contour of the glands on 1-mm. graph paper and counting the enclosed squares. The patients selected for normal values were those who had received their pneumograms for evaluation of disease in organs other than the adrenals. It is conceivable that the size of the adrenals

Fig. 2.—Tomogram of the left kidney and adrenal. Gerota's fascia appears as a thin membrane adjacent to the lateral border of the kidney. The adrenal is not well demonstrated at this level.



Figs. 3 and 4.—Two cases of adrenal hyperplasia. Both adrenals are increased in size in each case. The glands retain their normal triangular or semilunar shape.

In Figure 3 the right adrenal cross-sectional area is 11.3 sq. cm. and the left 13 sq. cm. In Figure 4, a tomogram, the measurements were 12.5 sq. cm. and 11.5 sq. cm.

may have been altered as a result of the disease process, but these changes are probably insignificant. The average cross-sectional area of this group of adult adrenals was 4.2 sq. cm. on the right side and 4.3 sq. cm. on the left side. The range on the right side was from 2.0 sq. cm. to 7.8 sq. cm. and on the left side from 2.0 sq. cm. to 8.7 sq. cm. There was no significant difference in the size of adrenals in the sexes.

ADRENAL NEOPLASMS

The tumors of the adrenal with which we are primarily concerned are hyperplasias of the cortex, cortical adenomas, adenocarcinomas, and tumors of the adrenal medulla or pheochromocytomas.

Extraperitoneal pneumograms were made in 10 proved cases of cortical hyperplasia with the characteristic symptoms, hormonal excretion patterns, and response to stimulation and inhibition by corticotropin (ACTH) and cortisone typical of Cushing's syndrome. Both adrenals of eight of these patients were visualized. The right adrenal of one patient appeared to be large but was not completely surrounded by the gas, and the left adrenal shadow of another patient could not be separated from that of the kidney. In the adults, the average area of the right adrenals was 12.0 sq. cm. and the left adrenals 12.3 sq. cm. The size ranged from 11.0 sq. cm. to 14.1

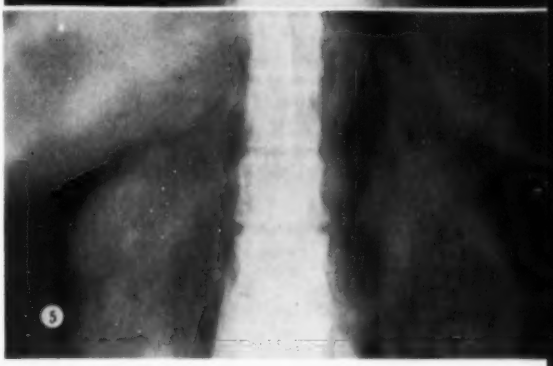


Fig. 5.—Adrenal hyperplasia. Both glands are enlarged. There is a rounded shadow projecting from the lower border of the left adrenal that may represent a localized adenomatous hyperplasia. The tomogram eliminates confusing shadows caused by gas in the gastrointestinal tract and adjacent areolar tissue. The right adrenal cross-sectional area was 12 sq. cm. and the left 12.5 sq. cm.

Fig. 6.—Tomogram. Small adenoma of the left adrenal arising from the lower border of an otherwise atrophic adrenal. The opposite adrenal was atrophic.

Fig. 7.—Tomogram. Moderate-sized adenoma of the left adrenal. The right adrenal is atrophic and barely perceptible on the roentgenogram.

Fig. 8.—Large adenoma of the right adrenal. The left adrenal is so small that it is not demonstrated.

sq. cm. on the right side and 8.5 sq. cm. to 16.0 sq. cm. on the left side. With the exception of one case in which the left adrenal measured 8.5 sq. cm., the adrenals were all larger than the largest encountered in the "normal" group (Figs. 3, 4, and 5). One 16-year-old patient, dwarfed as a result of her disease, had a right adrenal measuring 7.9 sq. cm. and a left adrenal of 5.0 sq. cm.

The bilateral enlargement of these adrenal glands helped differentiate this condition from cortical adenoma, in which the adrenals opposite the tumor were atrophic. Although considerably enlarged, the glands retained their triangular and semilunar shape. Three of the adrenals which were removed surgically contained small adenomas due to adenomatous hyperplasia, but these could not be identified on the roentgenograms. One patient who had a proved basophilic adenoma of the pituitary had bilaterally enlarged adrenals but also had a spherical shadow attached to the lower border of the left adrenal which presumably represented an area of adenomatous hyperplasia (Fig. 5).

The diagnosis of cortical hyperplasia on extraperitoneal pneumograms may be extremely difficult in some cases. In the absence of a unilateral adrenal tumor, it may be necessary to infer such an impression on the basis of the symptomatology of Cushing's disease.

There were four patients who had unilateral cortical adenomas and associated endocrine disturbances. Three of these had symptoms, physical findings and laboratory results found in Cushing's syndrome (Figs. 6, 7, and 8). One patient, a 14-month-old boy, had extreme virilism (Fig. 9). Two of these tumors were on the right side and two on the left. The masses differed from the hyperplasia cases in that the opposite adrenal was always small, and the tumors had changed shape so that they approached the contour of a sphere. The sharp angles seen in the normal gland appear rounded in the smaller tumors, which become more spherical in shape as they increase in size.

Fig. 9.—Huge adenoma of the left adrenal in a child with symptoms and signs of virilism. The mass is enclosed by Gerota's fascia. The kidney is displaced downward and rotated.

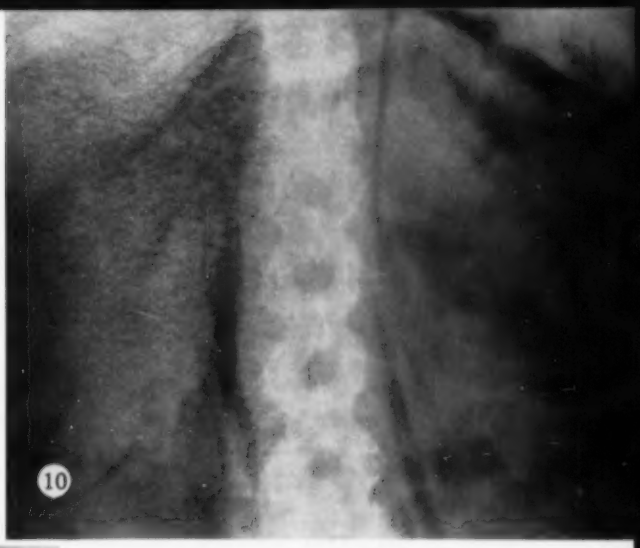


Fig. 10.—Adenocarcinoma of the left adrenal. The tumor is not clearly delineated by the retroperitoneal gas.

Fig. 11.—Normal adrenals. The shadow below the right adrenal and outlined by arrows was thought to be an adenoma but was found to be caused by fatty areolar tissue. The left adrenal is of normal size, instead of atrophic, as would be expected if there were a functioning tumor on the right.

Fig. 12.—Tomogram. Large pheochromocytoma replacing the left adrenal.

In one patient a spheroid tumor was seen arising from the lower border of an otherwise atrophic adrenal, and an atrophic adrenal was present on the opposite side (Fig. 6). These findings were confirmed at surgery.

Two patients had large cortical adenomas of the left adrenal glands without clinical or laboratory evidence of hypersecretion. Because of the absence of the more spectacular manifestations of the functioning adenomas, these tumors, having been diagnosed later, were larger. Otherwise, the tumors were identical.

In this group only one patient, a 30-year-old woman who presented typical Cushing's syndrome, had a malignant neoplasm. The pneumograms failed to outline the adrenals on either side. There was a slight fullness of the left kidney shadow, but no definite mass could be identified. The right adrenal, first

Fig. 13.—Bilateral adrenal pheochromocytomas.

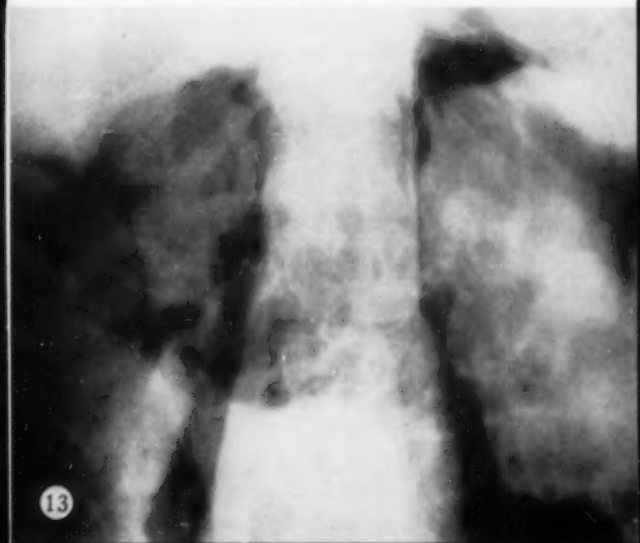


Fig. 14.—Both adrenals are extremely small. The cross-sectional area of the right adrenal was 0.3 sq. cm. and the left 1.1 sq. cm. An adrenal rest tumor or ovoblastoma was removed from the pelvis.

explored surgically, was found to be atrophic, and on the left side a 5-by-5 cm. nodular tumor had completely replaced the adrenal. The tumor, histologically an adenocarcinoma, had invaded the adrenal vein but had not infiltrated the neighboring fat (Fig. 10).

Pneumograms of one patient with equivocal symptoms and normal laboratory determinations suggested an adenoma of the right adrenal (Fig. 11). The adrenal was removed by surgery. Histologically it appeared normal. Below the adrenal a spherical mass containing normal fatty tissue caused the shadow which had been interpreted as an adenoma (Fig. 13). The areolar tissue produced a shadow that closely resembles the cortical adenoma illustrated in Figure 7. However, the opposite adrenal was of normal size instead of atrophic, as it is in patients with cortical adenoma.

One of the four patients encountered with pheochromocytoma had bilateral tumors, which are characteristic of approximately 20% of the patients with this disease. Pheochromocytomas may arise in the adrenal medulla or elsewhere in the sympathetic nervous system, but when present outside the adrenal medulla they have been referred to as paragangliomas, a term also used to describe the adrenal tumors. In contrast to adrenal cortex tumors, which almost invariably arise in the adrenal glands, pheochromocytomas have been found in the abdomen in paraganglionic tissue near the bifurcation of the iliac vessels and in other extra-abdominal sites.

The roentgen shadow cast by pheochromocytomas does not differ significantly from that of the adrenal adenomas and encapsulated carcinomas. It appears as a unilateral or bilateral spherical mass, generally replacing the adrenal, but occasionally lying outside of Gerota's fascia.

Two patients had single benign tumors arising within the adrenal medulla, one on the left side (Fig. 12) and the other on the right. One patient's tumor, which was present outside of Gerota's fascia and not attached to the adrenal, arose from the paraganglionic cells medial to the kidney pelvis. Another case presented two tumors of approximately equal size arising in each adrenal medulla (Fig. 13). In two patients, the opposite adrenals seemed small, but they were not explored at the time of surgery so that confirmation is lacking.

Under certain circumstances, bilateral small atrophic adrenals can indicate the presence of a secretory tumor in the gonads. A female patient with symptoms and signs of virilism and marked elevation of 17-ketosteroid urine excretion was suspected of hav-

Fig. 15.—Adenocarcinoma of the lower pole of the right kidney. The tumor is sharply demarcated and resembles a cyst.

Fig. 16.—Tomogram. Cyst of the upper pole of the right kidney. This lesion cannot be differentiated from an encapsulated malignant neoplasm. Renal calculus in the lower pole.

ing an adrenal tumor. The pneumograms revealed very small adrenals, measuring only 0.5 sq. cm. on the right and 1.1 sq. cm. on the left side. Exploration of the left adrenal revealed it to be atrophic, and an adrenal rest tumor, called an ovoblastoma, was found in the left ovary (Fig. 14). Another female patient with virilism whose extraperitoneal pneumograms also revealed very small adrenals, measuring 0.8 sq. cm. on the left side and 0.9 sq. cm. on the right side, has not yet been subjected to surgery.

RENAL NEOPLASMS

The kidneys do not ordinarily present as difficult a problem in roentgen interpretation as do the adrenals. Intravenous urograms and retrograde pyelograms supplemented by aortography or intravenous nephrography, if necessary, will establish the diagnosis of a mass, in most cases. Nevertheless, there are some cases, such as those with an associated complete block of the ureter, in which these examinations are equivocal or cannot be performed, so that additional information is desirable. In these cases extraperitoneal pneumograms may be helpful.

Malignant neoplasms of the kidneys, large enough to project beyond the outer margin of the cortex but which have not invaded the surrounding extraperitoneal tissues, will produce a rounded shadow (Fig. 15). Although these lesions may be present on any surface, they always lie within Gerota's fascia. Their demarcation is usually sharp, and unless metastases are visible they cannot be differentiated from a renal cyst (Fig. 16). If the tumor is more invasive, gas may be absent in the extraperitoneal tissues that have been infiltrated (Fig. 17), and in those cases the examination should be repeated to verify that the absence of gas in the perirenal area is not a result of a faulty injection. Inflammation and scarring resulting from previous inflammation can also interfere with the extension of gas into the perirenal region.

OTHER NEOPLASMS

Pneumograms may reveal any of the various types of tumors arising primarily in the retroperitoneal region. A patient who had

Fig. 17.—Extensive infiltration of the retroperitoneal tissues on the right side by a hypernephroma of the right kidney. The tumor prevents the gas from passing into the right side.

a known tumor on the left side which was diagnosed by the pathologist as reticuloendothelial hyperplasia had impaired filling with gas of the areolar tissue adjacent to the left psoas muscle (Fig. 18). Two patients with retroperitoneal involvement by Hodgkin's disease were examined. In one patient, gas injected into the presacral region twice remained in the pelvis because the retroperitoneal structures were extensively involved. In the other patient a mass occupying the entire left iliac fossa and extending into the

Fig. 18.—Infiltrating neoplasm involving the retroperitoneal tissues on the left side.

pelvic cavity prevented the gas from rising on the left side.

Metastases to the aortic and celiac lymph nodes must be quite large before they can be observed by this means. The midline structures, including the pancreas, are not easily identified because of the sparsity of areolar tissue and the shadows cast by the spine, major abdominal vessels, and the psoas muscles. If these lesions are large enough to extend laterally beyond the psoas muscles, they can be easily detected. Figure 19 is an example, best seen on tomograms, of chorio-

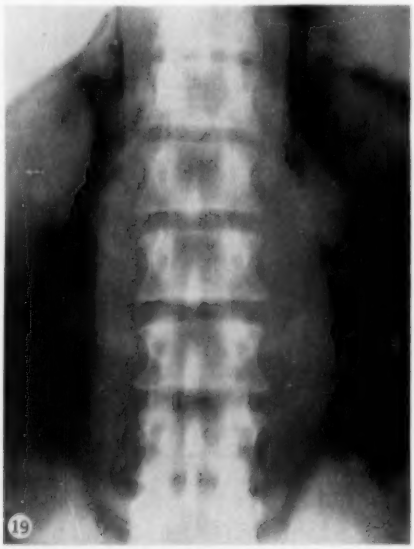


Fig. 19.—Metastases from choriocarcinoma of a testes to the para-aortic lymph nodes. The neoplasms produced a lobulated shadow extending laterally beyond the psoas muscles.

Fig. 20.—Tomogram. Cyst of the tail of the pancreas. The mass lies over the adrenal but is outside of Gerota's fascia.

carcinoma of a testis with extensive paraortic and celiac metastases which appeared on the roentgenograms as a midline mass with lobulated margins on both sides.

In the diagnosis of small tumors or cysts of the head of the pancreas, extraperitoneal pneumography is usually of no value, although larger lesions may be identified. The tail of the pancreas, however, is situated laterally in loose areolar tissue which is easily infiltrated by the gas, so that relatively small lesions may be visible. Because of the proximity of the tail of the pancreas to the left adrenal and superior pole of the left kidney, the differentiation of masses of these organs becomes imperative. This can be done by observing the position of Gerota's fascia. Because routine roentgenograms cannot always identify Gerota's fascia, tomograms may be required. Lesions of the adrenal and kidney lie within the fascia and cause it to bulge outward, whereas a mass of the pancreas lies outside of this structure (Fig. 20).

ACCIDENTS WITH EXTRAPERITONEAL PNEUMOGRAPHY

A questionnaire asking the number of cases studied, the gas used, and the incidence of severe reactions or deaths, was prepared and sent to a few institutions in which this examination was known to be used. Replies to these were tabulated along with our own results and the reported results of some other authors. There was no attempt to make a complete survey of the world literature.

Data were accumulated from 17 institutions with a total of 1,995 cases, including approximately 350 of our own; no deaths or serious complications were recorded. These cases were independent of the 1,500 cases collected by Mosca, in which there were no fatalities.[28] Some duplication of cases was probable in these two independent surveys. Information gathered from other sources indicated that some serious or fatal reactions had occurred in four patients during or following the injection of gas into the presacral tissue. Two cases resulted in death; there was one case of hemiplegia and one in which dyspnea, cyanosis, and shock followed the injection of gas, although recovery was complete. A brief review of these cases will be presented.

Case 1.—An adult male patient of Dr. F. H. Benteen ‡ was suspected of having an aneurysm of his right renal artery. The patient, in a knee-chest position, received an injection of approximately 170 cc. of room air into the areolar tissue between his rectum and sacrum. A local anesthetic preceded the injection, and the syringe was aspirated to be sure there was no penetration of a blood vessel. About 20 to 25 cc. of air was injected at approximately 20 to 25 cm. of water pressure. At this time the patient suddenly shifted his position forward. The injection was continued, and an additional 100 to 150 cc. of air was introduced. Then the patient suddenly stiffened and slowly moved forward. He was placed on his right side, but no pulse or heart beat could be elicited. About 75 cc. of air was aspirated from the right auricle.

An autopsy revealed a considerable amount of frothy blood in the right auricle, right ventricle, pulmonary artery, aorta, and coronary arteries. Dr. Benteen was of the impression that the needle had been displaced when the patient moved forward and that a retroperitoneal vein was perforated.

Case 2 (patient of Dr. R. E. McClellan §).—A 54-year-old woman was being examined for a possible pheochromocytoma. A presacral injection of gas was performed with the patient in the knee-chest position. After local anesthesia a No. 20 gauge spinal needle was directed into the presacral cellular tissue. After aspiration to be certain that a blood vessel had not been entered, 800 cc. of air was injected easily at a rate of 100 cc. per minute, with no appreciable discomfort to the patient.

About three or four minutes after the injection was completed, the patient complained of some heaviness in the flanks, nausea, and chest pain, and she was helped from the table into a chair. When her respirations became irregular and she developed a deep cyanosis, she was immediately placed on her left side on the table and intubated with an endotracheal tube. The characteristic "millwheel" murmur was not heard over the precordial area. She was given artificial respiration and respiratory and cardiac stimulants, but resuscitation was not successful. An autopsy was performed, and air was found in the coronary and cerebral vessels.

Case 3 (patient of Dr. R. E. McClellan §).—A 70-year-old man was examined for an equivocal renal tumor. He was placed in the knee-chest position, and a needle was inserted into the presacral

‡ Personal communication to the authors, April 22, 1954.

§ Personal communication to the authors, Feb. 5, 1954.

area. Six hundred cubic centimeters of air was injected manually without much pressure at a rate of approximately 100 cc. per minute. After the injection he developed syncope and fell over on his left side; he was given artificial respiration. His pulse was rapid, and he had a systolic blood pressure of 50 mm. of Hg. He also developed a left hemiplegia which resolved about 48 hours later. An EKG during the 10-minute period of vascular collapse showed auricular fibrillation, but the day following the procedure the EKG was normal.

The etiology of the shock and hemiplegia in this patient is not definite. It is possible that air embolism occurred, but the absence of the characteristic cardiac murmur and the association of auricular fibrillation leave some question as to whether a cerebral vascular embolus or thrombosis could not have occurred.

Case 4.—In the fourth case, reported by Russ, Glenn, and Gianturco,[22] a 74-year-old woman was subjected to extraperitoneal insufflation to localize a high retroperitoneal tumor. With the patient in the left decubitus position, the needle was inserted in the usual manner; aspiration was done without obtaining blood, and oxygen was injected at a pressure of 30 cm. of water. In about 15 minutes, 500 cc. of oxygen was injected without difficulty. Then the patient was placed in the prone position and the injection continued.

After the injection of another 100 cc. of oxygen she suddenly became dyspneic and cyanotic. The skin was clammy; the blood pressure was unobtainable, and the pulse irregular at 120 beats per minute. Two minims (0.25 cc.) of 1:1,000 epinephrine solution was administered, and the patient was rolled on her back. A loud "millwheel" murmur could be heard. When the patient was placed on her left side, the murmur disappeared and she became more comfortable. Gradually her pulse rate dropped and cyanosis disappeared. About three hours later a film of the abdomen revealed no gas in the extraperitoneal tissues, indicating that practically all of the oxygen had passed into the venous system.

In reviewing these accidents, some inferences can be made. Room air was used as the contrast medium in both fatal cases. Because of its nitrogen content air is not as soluble as oxygen and the lungs cannot excrete it as effectively.

The one patient who had gas embolism as a result of the intravenous injection of oxygen was placed on her left side soon after symptoms developed, and recovery was complete. Durant has shown [8] that in dogs the factors which were most closely related to mortality in experimental production of pulmonary gas emboli were the amount of air injected, the speed of injection, the effectiveness of the pulmonary excretory mechanism, and the position of the animal. He found that the animal can tolerate more air when lying on its left side than in any other position. Furthermore, if an animal showed evidence of marked right ventricular failure while lying on its back and was then turned onto the left side, immediate recovery was common. Death was due to circulatory obstruction resulting from an air trap in the right ventricular outflow tract, but when the body was turned to the left lateral position the air trap was displaced.

In this connection, it is noted that Patient 1 was placed on the right side after the onset of symptoms. Patient 2 was placed on the left side, but apparently the embolization had proceeded too far to permit recovery, because gas was present in the coronary and cerebral vessels. Patient 4 recovered completely after she was placed on the left side. Musgrove and MacQuigg [14] have also reported a case of gas embolism during pneumoperitoneum, with recovery when the patient was turned onto the left side.

Patient 1 moved forward during the course of the injection, and this movement probably caused the needle to enter a vessel. This case emphasizes the fact that if there is any question of movement of the needle the injection should be stopped and aspiration attempted before continuing. Also, as suggested by McClellan, patients in the uncomfortable knee-chest position used in the first three cases are more inclined to move than when they are placed in the lateral or prone positions. In a previous report we recommended the injection of oxygen slowly under a controlled pressure of 15 to 30 cm. of water, which is just above the positive pressure of the tissue into which the gas is introduced. If greater pressure is required, the position of the needle is not correct and should be adjusted.

SUMMARY

The injection of oxygen into the areolar tissues between the rectum and the sacrum

provides a method for the roentgen demonstration of the retroperitoneal structures. This technique has been particularly useful for the detection of diseases of the adrenal gland.

The cross-sectional area of normal adrenal glands on anteroposterior films was measured with a compensating polarimeter. The average area was 4.2 sq. cm. on the right side and 4.3 sq. cm. on the left side. The range on the right side was from 2.0 sq. cm. to 7.8 sq. cm. and on the left side from 2.0 sq. cm. to 8.7 sq. cm.

Both adrenal glands were enlarged in patients with adrenal cortex hyperplasia. The average cross-sectional area of the right adrenals was 12.0 sq. cm. and of the left adrenals 12.3 sq. cm. The size ranged from 11.0 sq. cm. to 14.1 sq. cm. on the right side and 8.5 sq. cm. to 16.0 sq. cm. on the left side.

In patients with cortical adenomas, the contralateral adrenal was small on the roentgenograms

Pheochromocytomas may arise within the adrenal or in the extra-adrenal paraganglionic tissue. The intra-adrenal neoplasms cannot be differentiated from cortical adenomas by roentgen means.

Tumors of the kidneys and other retroperitoneal organs are discussed. The importance of Gerota's fascia in identifying masses in the adrenal and renal areas is emphasized.

A survey is presented of 1,995 cases in which this procedure has been used without serious reactions. Case histories of two patients who died and two patients who had severe reactions following the introduction of a gas into the extraperitoneal tissues are discussed.

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ABDOMINAL AORTOGRAPHY

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ABDOMINAL aortography is a roentgen method for the use in differential diagnosis between intrarenal and extrarenal retroperitoneal masses. It is helpful for the roentgen differentiation between benign and malignant tumors of the kidney.

This method was first described by dos Santos,[1] of Portugal, in 1925. It did not receive wide acceptance until a publication by Farinas of Cuba in 1941.[2] Nelson,[3] of Seattle, reported the first cases of translumbar aortography done in this country in 1942. In 1948 Melick and Vitt[4] reviewed 3000 cases of aortography collected from the literature. In a recent paper, Smith, Evans, Elsey, and Felson, of Cincinnati,[5] reported a total of 800 cases of translumbar aortography done at their institution without a fatality. They also include a complete bibliography on this subject.

The purpose of the present paper is to review the value of abdominal aortography in the differential diagnosis of retroperitoneal masses and to point out the diagnostic criteria used in the roentgen visualization of these tumors. The following outline will be used for the purpose of discussion in this paper.

RETROPERITONEAL TUMORS

I. Extrarenal Tumors
  A. Primary tumors
    (*a*) Embryologic remnants of the genitourinary tract
    (*b*) Neurogenic tumors
    (*c*) Adrenal tumors
  B. Metastatic tumors
    (*a*) Carcinoma
    (*b*) Sarcomas (including lymphomas)
II. Renal Tumors
  A. Benign cysts
  B. Malignant tumors
    (*a*) Carcinomas
      1. Epithelial tumors of the renal pelvis
      2. Adenocarcinoma of the renal parenchyma (hypernephroma)
    (*b*) Sarcomas
      1. Embryonal (Wilms's tumor)
      2. Others

It is important for the surgeon to know (1) whether he is dealing with an extrarenal or an intrarenal mass and (2) whether it is a malignant or a benign tumor. Aortography is a nonhistological means of making this differentiation. The method described herein has been found to be relatively simple and to require no expensive new x-ray or other equipment, which makes its use in smaller departments quite feasible.

TECHNIQUE

The technique of aortography used here is similar to that described by Smith, Rush, and Evans.[6] The patient is placed prone on the x-ray table and anesthetized with thiopental (Pentothal) sodium intravenously. An 18-gauge, 6-in. (15 cm.) needle with stylet is connected through plastic tubing to a 10-cc. syringe, which is filled with contrast medium, such as 70% sodium acetrizoate (Urokon). (It is important that the syringe not be filled until the operator is ready to inject it.) The needle is introduced just below the 12th rib about 5 fingerbreadths to the left of the spinous processes and is passed inwardly and medially until it meets the body of the 12th thoracic vertebra. It is then walked anteriorly

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Fig. 1 (Case 1).—Abdominal aortogram showing aortic aneurysm.

along the vertebra until the aorta is reached and entered. The stylet is then removed from the needle; the syringe and tubing are attached, and the opaque material is injected within a period of one and one-half to two seconds. As the last of it is injected, the first film is made. Rapid changing of the casette will give a second exposure to obtain a nephrogram.

EXTRARENAL TUMORS

Extrarenal tumors, as shown in the above outline, may be either primary or secondary. Some of them may not even be neoplastic but rather masses of vascular origin, such as an aneurysm of the aorta. Case 1 is an example of the use of this method in the demonstration of an aneurysm of the abdominal aorta.

Fig. 2 (Case 2).—*A*, retrograde pyelogram demonstrating lateral displacement of lower pole of left kidney and upper one-third of left ureter by soft tissue mass; *B*, aortogram showing extensive vascularization of benign pheochromocytoma which produced the pyelographic findings in *A*.

Case 1.—A 49-year-old man complained of progressively increasing pain in the midabdomen for six weeks. A smooth mass in the umbilical region, beginning at the level of the third lumbar vertebra was shown by aortography to be a large abdominal aortic aneurysm (Fig. 1).

Extrarenal neoplastic masses are well illustrated by Case 2.

Case 2.—A 40-year-old woman with hypertension of two years' duration was admitted because of intermittent generalized headache. Examination revealed a palpable left abdominal mass, and retrograde pyelography (Fig. 2*A*) revealed lateral displacement of the lower pole of the left kidney and the proximal third of the left ureter by an ill-defined soft tissue mass with calcific mottling. Abdominal aortography (Fig. 2*B*) revealed a very vascular mass which was subsequently proved to be a benign pheochromocytoma lying just medial to the left kidney.

Fig. 3 (Case 3).—Attempted aortogram showing opaque material injected into metastatic hepatoma which had obstructed the inferior vena cava and the aorta. Note the venous channels filled with opaque medium.

Fig. 4 (Case 4).—*A*, retrograde pyelogram showing deformity of the middle and inferior calyces of the right kidney; *B*, aortogram showing displaced vessels in the lower pole of the right kidney surrounding a cyst.

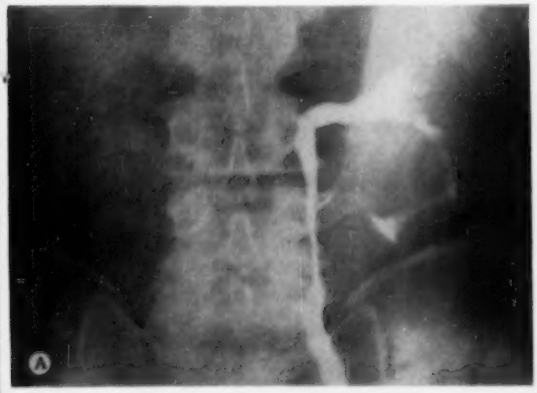
Case 3.—A 54-year-old man with cirrhosis of the liver and persistent dependent edema despite treatment. Opaque material was injected into the right femoral vein, and complete obstruction of the inferior vena cava at the level of the 11th thoracic vertebra was suggested. Attempted aortography resulted in direct injection of the opaque medium into a large tumor mass intimately connected with the aorta and inferior vena cava (Fig. 3). Autopsy revealed this to be a hepatoma extending into these large vessels.

Case 3 demonstrates what can happen during attempted abdominal aortography for retroperitoneal masses. In this case the needle apparently was inserted directly into the tumor and demonstrated its venous connection with the inferior vena cava.

The above three cases are thought to be representative of extrarenal retroperitoneal masses and to be illustrative of the value of the method in them.

Fig. 5*a* (Case 5).—Retrograde pyelogram of the left kidney showing marked distortion and elongation of the inferior calyx.

Fig. 5*b* (Case 5).—Aortogram showing some deviation of the vessels in the lower pole of the left kidney with no characteristic appearance as would be expected with a primary carcinoma of the kidney pelvis.



RENAL TUMORS

The differential diagnosis between benign and malignant tumors of renal origin is very important to both the surgeon and the patients. An example of a benign tumor mass of the kidney is given in Case 4.

CASE 4.—A 52-year-old white man with the chief complaint of gross hematuria of one weeks' duration was found by retrograde pyelography (Fig. 4*A*) to have compression and displacement of the inferior and middle calyces and infundibulae by a mass in the lower portion of the right kidney. Abdominal aortography showed the tumor to be avascular with the adjacent vessels displaced, consistent with a cyst (Fig. 4*B*). This was subsequently confirmed by right nephrectomy.

Papillary carcinoma of the kidney and pelvis gives no characteristic roentgen appearance other than the evidence of a renal mass without increased vascularity. The vessels are displaced by the mass essentially the same as the calyceal displacement that is present. Definite "laking" or pooling of the opaque material in the region of the tumor is not seen. Case 5 is an illustration of this phenomena.

CASE 5.—A 65-year-old man with hematuria, weakness, and weight loss showed on retrograde pyelography (Fig. 5*A*) an enlargement of the left renal shadow, with distortion and compression of calyces and a coarsely irregular filling defect of the left kidney pelvis. Abdominal aortography showed a large avascular lesion of the left kidney with no "laking" or pooling of the opaque material (Fig. 5*B*). This was found at surgery to be a primary carcinoma of the kidney pelvis.

Renal-cell carcinoma of the kidney customarily gives a typical roentgen appearance during aortography. Case 6 is an example of the typical appearance of such a tumor. Note the extensive pooling and "laking" of the opaque material and the irregularly dilated sinusoids of this very vascular tumor.

CASE 6.—A 73-year-old white woman with a five-day history of frequency, dysuria, and gross hematuria. A palpable mass in the right flank was noted and attempted retrograde pyelography showed no filling of the right kidney structures. Aortography revealed areas of pooling and "laking" in the lower portion of the right kidney (Fig. 6). Subsequent histologic study of the biopsy specimen showed a typical renal-cell carcinoma of the right kidney.

From the preceding case, it is apparent that abdominal aortography is of considerable value in the differential diagnosis between extrarenal and intrarenal tumors. It is frequently of value in determining whether these masses are benign or malignant neoplasms. Aortography, of course, as will be pointed out by others, can be combined with other diagnostic procedures, such as pyelography or retroperitoneal air injections, and considerable additional information can be obtained.

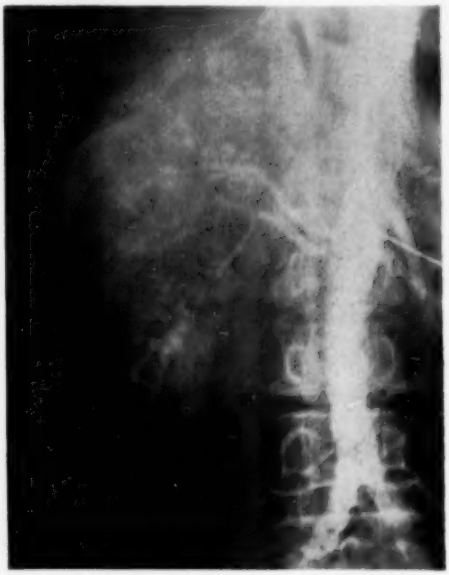


Fig. 6 (Case 6).—Aortogram of right kidney showing typical "pooling and laking" of the opaque medium in a renal cell carcinoma.

In patients in whom the typical pooling or "laking" of the blood is seen, one can be reasonably sure of the histologic diagnosis of renal cell carcinoma without any additional findings. However, it should be pointed out that aortography is only one tool in our diagnostic arsenal directed against retroperitoneal masses. No one specific method will give the answer in every case, but we should be familiar with them all. Cooperation of the urologist and the radiologist will continue the development of the teamwork so essential in the early accurate diagnosis of these puz-

zling cases. It is only as we improve our ability to reach a more definitive and earlier diagnosis that we may hope to increase the survival rate in these patients.

SUMMARY

A review of abdominal aortography in the differential diagnosis of retroperitoneal masses has been given.

The method is of considerable value in the differential diagnosis between extrarenal and renal tumors.

It aids in the differentiation between benign and malignant renal tumors.

Aortography may be combined with other urological procedures to further differentiate masses in selected cases.

Several of the cases shown have been previously reported by Dr. David Shapiro (*Radiology* **60**:1-17 [Jan.] 1953), and are used with permission. The aortogram in Case 2 is from the Oak Ridge Hospital and was loaned by Dr. Herbert D. Kerman, formerly radiologist there. The aortogram in Case 3 was kindly loaned for the purpose of this study by Dr. Benjamin Felson of the Department of Radiology, University of Cincinnati.

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ROENTGEN EXAMINATION IN RETROPERITONEAL TUMORS OF CHILDREN

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THE PROBLEM of the roentgen diagnosis of retroperitoneal tumors in infants and children is simplified by the fact that these tumors are almost exclusively one of three types: (1) renal embryoma (Wilms tumor), (2) neuroblastoma, and (3) unattached embryoma (teratoma). Other retroperitoneal tumors, such as rhabdomyosarcoma and lymphoma, occur in children rarely, but the numerous other tumor types commonly encountered in adults are virtually unknown in these young patients. Thus when an infant or child with evidence of abdominal mass is presented for roentgenologic study, the various diagnostic procedures should be carried out with the purpose of demonstrating the features of one of these three retroperitoneal tumors.

TYPES

The nature of these tumors can be briefly summarized.

Renal Embryoma (Wilms Tumor).—This is the usual renal tumor of early life. It comprises 20% of neoplasms in children. Although first described by Gairdner in 1828, Wilms's classic description has linked his name to this tumor. It develops as a well-encapsulated tumor in the renal parenchyma, usually at one renal pole, and attains a large size before its capsule ruptures and infiltration of the perinephric structures occur. Necrosis and hemorrhage within the tumor are common. Histologically, the renal embryomas exhibit a variety of mesodermal cell structure and, depending upon the dominant cell type, may be designated sarcoma, adenosarcoma, rhabdosarcoma, or adenomyosarcoma.

Neuroblastoma.—Although Virchow first recognized the nature of this malignant tumor, Wright (1910) first used the term neuroblastoma to describe it after noting the similarity of its tumor cells to those of the fetal adrenal medulla. Neuroblastomas occur anywhere in the sympathetic nervous system. About 60% arise in the abdomen from the adrenal medulla, celiac ganglion, thoracolumbar sympathetic chain, organ of Zuckerkandl, or sacrococcygeal body. Most neuroblastomas are rapidly growing, highly malignant tumors, but Farber [1] has found that they may either undergo spontaneous hemorrhage and necrosis and disappear, or, by spontaneous maturation, become benign ganglioneuromas. Neuroblastomas are initially encapsulated, but early in their development they tend to break out and extend along nerve roots or tissue planes to invade the surrounding organs. Metastasis occurs by lymphatic spread and by blood stream to the liver, bone marrow, skull, and meninges. In 60% of Wittenborg's [2] series, metastases were present at the time of hospitalization.

Retroperitoneal Teratoma.—Retroperitoneal teratomas are solid or cystic encapsulated growths arising high in the abdomen in the pancreatic or renal area or in the retroperitoneal space on either side of the vertebral column. These teratomas, or embryomas, have been called "unattached" in order to emphasize their independence from the adrenal or kidney, although they are thought to be derived from remnants of the pronephros or mesonephros. Almost all are tridermal in structure and most are benign. Only 6.8% of Arnheim's [3] collected series of 44 cases had malignant components. Most

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of these tumors contain teeth or bone, a feature of great importance from the roentgenologic standpoint.

In order to determine whether there are characteristics which might aid in a specific roentgenologic diagnosis, the clinical records and roentgenograms of 74 cases of retroperitoneal tumor encountered at the Childrens Hospital of Michigan in the period 1940 to 1953 were analyzed. Only those cases were accepted in which operation or postmortem examination had provided pathologic proof of the nature of the tumor, and roentgenologic studies consisting of at least plain film studies of the abdomen, urography (either excretory or retrograde), and chest and long bone roentgenograms were required. Thus only 55 cases were found to be satisfactory for study. Two of these were cases of renal neurofibroma and lymphosarcoma arising in the urinary bladder area, respectively, and are not included in the analysis.

The 53 cases analyzed include 25 renal embryomas, 23 neuroblastomas of abdominal origin, and 5 retroperitoneal teratomas. The clinical and roentgenologic features of these Wilms tumors, neuroblastomas, and retroperitoneal teratomas have been carefully compared.

TABLE 1.—*Age Distribution of Twenty-Five Cases of Wilms Tumor*

Age	Cases, No.
0 to 1 yr.	3
1 to 2 yr.	4
2 to 3 yr.	4
3 to 4 yr.	9
4 to 5 yr.	2
5 to 6 yr.	2
6 to 7 yr.	1

TABLE 2.—*Age Distribution of Twenty-Three Cases of Neuroblastoma*

Age	Cases, No.
0 to 1 yr.	7
1 to 2 yr.	6
2 to 3 yr.	2
3 to 4 yr.	3
4 to 5 yr.	2
5 to 6 yr.	1
7 yr., 11 mo.	1
10 yr., 4 mo.	1

TABLE 3.—*Presenting Symptoms in Twenty-Five Cases of Wilms Tumor*

Symptom	Patients
Abdominal mass	15
Abdominal pain	10
Anorexia	6
Fever	3
Hematuria	3
Pallor	2
Weight loss, constipation, "anemia"	1 each

TABLE 4.—*Presenting Symptoms in Twenty-Three Cases of Neuroblastoma*

Symptom	Patients
Abdominal mass	14
Abdominal pain	3
Extremity pain	6
Fever	3
Anorexia	3
Weakness	2
Exophthalmos	2
Weight loss, vomiting, constipation, diarrhea, pallor	1 each

CLINICAL FEATURES

Age (Tables 1 and 2).—Although the average age at admission in the two major groups (Wilms tumor and neuroblastoma) is practically the same, the age distribution chart shows the peak incidence for renal embryoma to be 3 years, while that of the neuroblastomas is between 1 and 2 years. Wilms tumors rarely occur after the age of 6 years, while neuroblastomas may be found throughout childhood and, with some frequency, in adult life. The teratomas in this group were all found before the age of 1 year.

Sex.—Wilms tumors: 13 males, 12 females; neuroblastomas: 14 females, 9 males; retroperitoneal teratomas: 2 females and 3 males. According to most authorities, there is no sex predilection in the tumors of congenital type found in infants and children. The results in this small series confirm this fact.

Race.—Twenty white and 5 Negro children were afflicted with renal embryoma; 16 white and 7 Negro children with neuroblastoma; all 5 teratomas occurred in white children. No racial factor in these tumors has been reported in the literature. The number of Negro children in this present series is high in comparison with other pub-

lished reports, but the type of hospital population explains this apparent discrepancy.

Symptoms.—The various symptoms noted on admission in the Wilms tumor and neuroblastoma cases are listed in Tables 3 and 4.

An abdominal mass is a prominent sign in all three of the tumors under discussion. Most often the mass is fairly large and easily palpable when the patient is first examined. Occasionally, however, the abdomen of an infant or child containing a large mass may have been examined by a competent physician a month or a few weeks previously, when no abdominal mass was detectable. This circumstance, mentioned also by other authors, occurs with sufficient frequency to emphasize the rapid proliferating nature of these tumors.

Hematuria is an infrequent symptom of renal embryoma and, when it does occur, indicates that neoplastic invasion of the renal pelvis has probably taken place.[4] Hematuria has not been encountered in any of these cases of neuroblastoma, even though direct invasion of the renal parenchyma is occasionally a part of the natural history of this tumor.

Pain of the "rheumatic" type in the extremities is not an uncommon initial complaint in cases of neuroblastoma and indicates that bone metastasis has already occurred. Similarly, vomiting and headache suggest intracranial involvement, and exophthalmos or orbital ecchymosis signals invasion of the retrobulbar tissue by metastatic neuroblastoma cells.

In all of the cases of teratoma an abdominal mass was the striking symptom, and in two cases an abnormal abdominal contour had been observed from birth. In one case tarry stools of intermittent nature were reported, and subsequently ulceration of the stomach mucosa by a retrogastric teratoma was disclosed at operation.

Physical Signs.—Elevation of the temperature (100 F, or more) was recorded in 16 of the Wilms tumor cases, probably indicating necrosis of portions of the rapidly expanding tumor. Fever is less common in neuroblastoma (9 of 23 cases) and retroperitoneal teratoma (1 of 5 cases).

The systemic blood pressure was recorded in only 7 of the 25 cases of Wilms tumor and was found to be elevated (systolic pressure above 120 mm. Hg) in 2. In six neuroblastoma cases one showed an abnormally high systolic blood pressure. In none of the teratoma cases was the blood pressure recorded. Obviously no conclusion can be drawn from these meager records, and the presence of hypertension in 75 to 90% of Wilms tumor cases, as is suggested by various reports,* cannot be confirmed or denied. The cause of the hypertension is not known, but it it thought to be due to impedance of renal arterial circulation by the Wilms tumor. Hughes and co-workers[7] state that clear-cut hypertension in a child with a kidney area mass points toward the probability of Wilms tumor.

Roentgen Features.—The imperative nature of the diagnosis and treatment of these tumors should be strongly stated. All three tumors, particularly renal embryoma and neuroblastoma, can grow very rapidly, and once their presence is detected or suspected on palpation of the abdomen, roentgenograms of the abdomen should be immediately obtained. In almost all instances, the palpable tumor mass will be demonstrated roentgenographically, and as soon as possible excretory urography should be performed to determine the relationship of the mass to the urinary tract. Excretory urography is proposed (in preference to cystoscopy and retrograde urography) because it can be accomplished as an emergency measure without necessity of special preparations for the patient or physician. In addition, the intravenous urogram demonstrates the functional status of the involved and uninvolved kidney. Roentgenographic study of the chest, long bones, and skull should be instituted in every case before definitive treatment is anticipated. Contrast studies of the upper intestinal tract and colon have been performed in some instances but have proved to be of little value

* References 5 and 6.

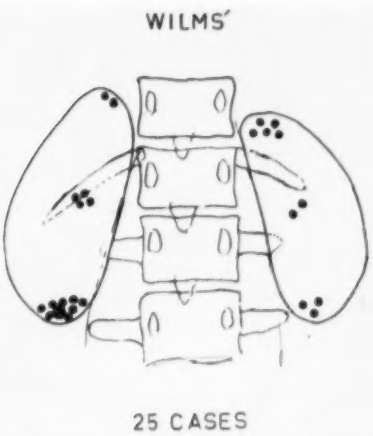


Fig. 1.—Distribution of 25 Wilms's tumors as determined by operation or postmortem: 15 in the right kidney, 10 in the left.

in diagnosis. Special studies such as perirenal air injection, retroperitoneal emphysema, pneumoperitoneum, and aortography have not been employed in any of the 53 cases.

Seemingly the differential diagnosis between an intrarenal mass, such as Wilms tumor, and an extrarenal neoplasm like neuroblastoma should be conclusively made by urography. Such is not the case, and in fact many authors † claim that the separation of the two by urographic means is not possible. Campbell ‡ states that the distinction between Wilms tumor and neuroblastoma cannot always be made, particularly when the neuroblastoma by extrarenal pressure causes compression and distortion of the pelvis and dislocation of the kidney. Gross [8] says that generally it is impossible by plain films or pyelograms to differentiate roentgenologically between neuroblastoma, embryoma of the kidney, and unattached retroperitoneal teratoma. In one series of cases,[12] there was distortion of the intrarenal structures in 75% of cases of neuroblastoma and in only 71% of cases of Wilms tumor.

Mass: All three types of tumor may produce roentgenographic evidence of a soft tissue mass on plain film studies. In fact, all of the Wilms tumors and teratomas did so, and only one of the neuroblastomas failed to visualize. In this case no mass could be palpated by clinical examination of the abdomen. In two of the neuroblastoma cases in which no mass in the abdomen could be detected clinically, roentgenograms of the abdomen demonstrated the mass.

The gas-filled bowel may be displaced by the retroperitoneal mass, and in several of the large Wilms tumors the diaphragm on the affected side was elevated.

Nodularity of the neuroblastomas and indefinitiveness of their borders, recognized by some authors by clinical examination, cannot be demonstrated by roentgenograms, or is the smooth or lobulated distinct outline of the Wilms tumor shown.

Location of the tumor within the abdomen can be determined with some degree of accuracy by roentgenographic study, except when huge tumor masses exist. The actual

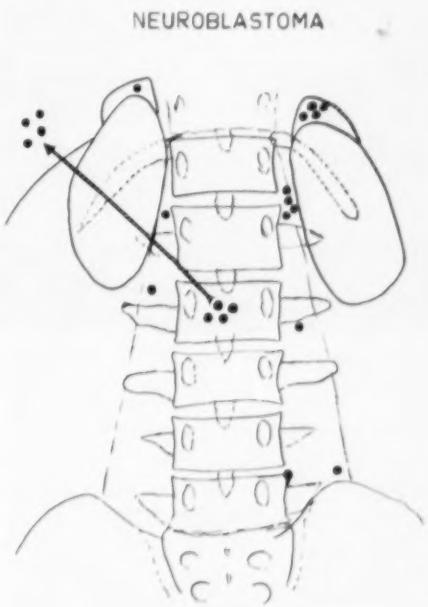


Fig. 2.—Distribution of 18 abdominal neuroblastomas as determined by operation or postmortem: 5 of adrenal origin, 9 from the lumbar sympathetic chain, and 4 large tumors filling abdominal cavity and extending to the liver.

† References 8 through 11.

‡ Campbell, M. F., in discussion of Wittenborg.[2]

site of origin of the tumor was determined in all 25 cases of Wilms tumor either at operation or at postmortem study. The distribution of these tumors within the kidney is shown in Figure 1. In four tumors of the right kidney and two of the left kidney the entire renal substance was involved, and the original site of the tumor could therefore not be determined. In only 18 of the 23 neuroblastomas was the site or origin of the tumor found (Fig. 2). In four neuroblastomas large tumor masses filling the entire abdominal cavity were encountered, and in all four extension or metastasis to the liver

Fig. 3.—Plaque-like calcification at periphery of Wilms tumor.

had occurred. Extension of the tumor mass across the abdominal midline was recorded in 10 of the Wilms tumors and in 7 of the neuroblastomas. Only one of the five teratomas was confined to one side of the abdomen.

Calcification: Two of the Wilms tumors showed linear plaque-like calcification at their peripheries (Fig. 3). This incidence of calcification (8%) and the character of the calcific deposit in both cases correspond to the experience of Steinbach and Brown,[12]

Fig. 4.—Flocculent calcification in central portion of large neuroblastoma arising from right adrenal.

Fig. 5.—Decrease in size of mass after radiation therapy. Type and density of calcification unchanged.

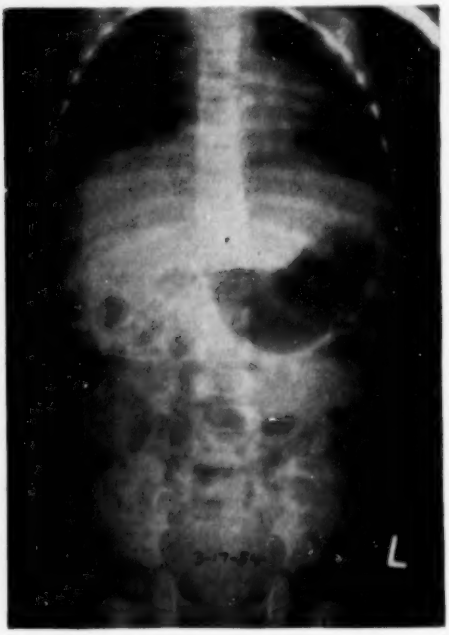


Fig. 6.—Ring-like linear calcification outlining circumference of neuroblastoma. In central portion is flocculent calcific deposition.

who found a 12% incidence of dense, homogeneous, concentric rings of calcification in the peripheries of the Wilms tumors. Eleven (47%) of the 23 neuroblastomas exhibited calcification of one of two types—either flocculent punctate areas scattered throughout the mass, particularly in its central portion (Figs. 4 and 5), or linear deposition at the circumference of the tumor (Fig. 6). The linear variety was seen in only two cases and then in association with central flocculent deposits. This neuroblastoma calcification agrees in incidence and type with those previously reported.§ Calcified cartilage and bone were unquestionably demonstrated in three of the retroperitoneal teratomas (Fig. 7). Bone or tooth inclusion shown roentgenographically is the significant diagnostic feature of the retroperitoneal teratoma, without which definitive diagnosis cannot be made. The bony component of the teratoma may be so well developed that a digit or "limb" may actually be demonstrated.[18]

Change in Renal Contour: As the Wilms tumor arises from the renal parenchyma and remains encapsulated for a considerable period before the renal capsule is broken, it may either produce a localized deformity of renal outline at either pole or, as in most cases, completely erase any semblance of reniform contour. Many neuroblastomas arising either from the adrenal gland or abdominal sympathetic chain in close proximity to the kidneys obliterate the renal outline by completely or partially encircling the kidney while respecting its capsule or by actually invading the renal substance. In about one-half (10 of 23 cases) of the neuroblastomas in our series, however, the renal outline on the involved side was clearly maintained (Fig. 8). In all of the unattached embryomas this was the case (Fig. 9). Thus it should be stressed that if in the presence of a retroperitoneal mass, demonstrable clinically or roentgenologically, the kidney outline is maintained, the possibility of Wilms tumor is remote, and neuroblastoma or teratoma should be therefore considered.

Renal Displacement: Displacement of the kidney or kidneys can occur in any of the three tumors under consideration. In three

Fig. 7.—Irregular spicules of bone within retroperitoneal teratoma.

§ References 13 and 14.

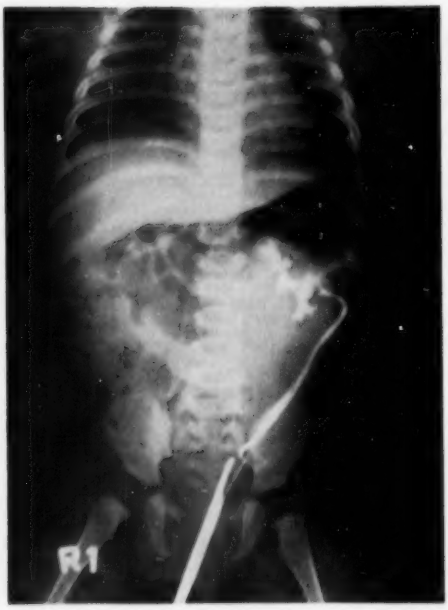


Fig. 8.—Retrograde ureteropyelogram shows lateral displacement of kidney and ureter by paravertebral neuroblastoma. The renal outline has been maintained.

of the Wilms tumors there was no renal displacement; the direction of displacement in 20 others is listed in Table 5. Five of the neuroblastoma cases showed no renal displacement; the type of renal displacement noted in 13 other cases is shown in Table 6. In two of the Wilms tumors and in five of the neuroblastomas the mass was so huge that a displaced kidney could not be identified on roentgenograms. In retroperitoneal teratoma lateral or downward renal displacement is the rule.

TABLE 5.—*Renal Displacement in Twenty Cases of Wilms Tumor*

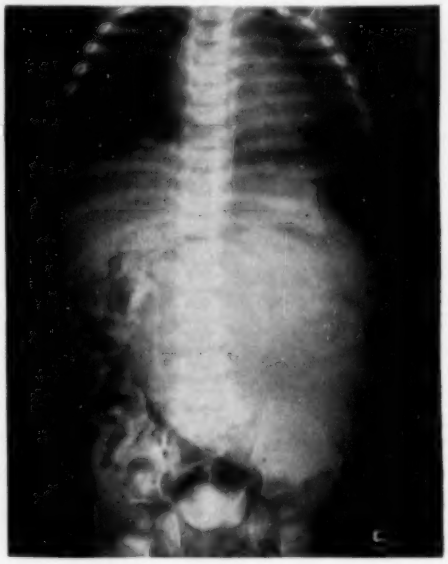
Displacement	Cases, No.
None	3
Medial only	0
Medial and cranial	4
Medial and caudal	1
Lateral only	1
Lateral and cranial	2
Lateral and caudal	3
Cranial only	3
Caudal only	3

TABLE 6.—*Renal Displacement in Eighteen Cases of Neuroblastoma*

Displacement	Cases, No.
None	5
Medial only	0
Medial and cranial	0
Medial and caudal	1
Lateral only	6
Lateral and cranial	0
Lateral and caudal	5
Cranial only	0
Caudal only	1

The degree of kidney displacement was not shown to vary with the type of retroperitoneal tumor in this group, although it appears that Wilms tumors arising from the lower pole of the kidney are capable of gross cephalic and medial displacement of a degree not seen in any of the neuroblastoma cases or teratomas. Worth mentioning is the lack of medial and upward renal displacement in the neuroblastoma group, while these two directions of displacement as stated are fairly frequently displayed by renal neoplasms. Pronounced downward kidney displacement is suggestive of neuroblastoma; urographic evidence of downward compression of the

Fig. 9.—The left kidney is enlarged and flattened by a large retroperitoneal teratoma, but the renal contour is clearly maintained.



renal pelvis as well points even more strongly to that diagnosis.

Steinbach and Brown,[12] after studying a group of cases of Wilms tumor and neuroblastomas, concluded that the kidney is frequently displaced by both types of tumors; however, (in their series) the neuroblastomas always displaced the kidney downward, or downward and slightly outward. In most instances the Wilms tumors in their series also displaced the kidney downward and outward, but in some instances upward and medially.

Renal Function: Seven of the 23 cases of Wilms tumor submitted to excretory urography exhibited nonfunction of the involved kidney. Nonfunction of a kidney involved by neoplasm, according to Riches and colleagues,[16] may indicate that the renal vein is involved, that the greater part of the kidney is destroyed by tumor, or that the ureter is blocked by growth or blood clot. Retrograde urograms performed in four of these seven cases demonstrated the Wilms tumor, and in none could tumor tissues or blood clot be demonstrated in the renal pelvis.

Fig. 10.—Compression, elongation, and distortion of pelvis and calyces of right kidney by embryoma arising in lower pole.

Fig. 11.—Calyceal compression and distortion from large embryoma of upper renal pole.

In two of the neuroblastoma cases there was nonfunction of the ipsilateral kidney. In

Fig. 12.—Calyceal elongation and compression due to embryoma of upper right renal pole. This type of calyceal deformity can also occur in solitary renal cyst.

Fig. 13.—Elongation and distortion of superior calyx of left kidney. Neuroblastoma surrounding kidney disclosed at operation.

Fig. 14.—Caliectasis and pyelectasis of laterally displaced left kidney. Neuroblastoma arising from sympathetic chain in left paralumbar region.

both cases, it was later shown that the entire kidney, including the hilus, was surrounded by tumor tissue which apparently blocked the ureter or interfered with the renal blood supply.

In the four cases of retroperitoneal teratoma, in which intravenous urography was performed, the function of the kidneys and the pyelographic pattern were normal.

Pyelocalyceal Pattern: In this series 88% of cases of Wilms tumors showed evidence of intrarenal mass, indicated by either (1) calyceal elongation, compression, or distor-

Fig. 15.—Normal pyelocalyceal pattern of right kidney which is displaced by calcified right adrenal neuroblastoma.

tion, or (2) alteration of renal pelvic outline or capacity (Figs. 10, 11, and 12). The remaining 12% of Wilms tumors exhibited hydronephrosis only, but the size of the renal mass in these three cases was disproportionate to that of the dilated renal pelvis and calices, thus eliminating the possibility of simple hydronephrosis.

The types of pyelocalyceal deformity seen in these Wilms tumor cases correspond to those described so well by Campbell as "bizarre." In none of our cases was the

pelvocalyceal pattern entirely normal. Such instances have been reported, however.

Some of the neuroblastoma cases (33%) exhibited changes in the urographic pattern indistinguishable from those of the Wilms tumor group (Fig. 13), while the other 67% showed simple hydronephrosis (three cases) (Fig. 14) or a normal pyelocalyceal pattern (nine cases) (Fig. 15). In many of the cases with normal pattern, the kidney was displaced to a greater or less degree.

In none of the four retroperitoneal teratomas in which pyelography was performed

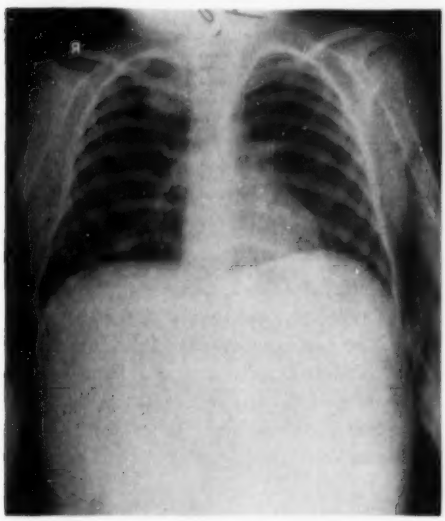


Fig. 16.—Nodular metastases in right lung parenchyma. Wilms tumor.

was there any deformity of the renal pelvis or calices.

In all instances in the three types of tumors the ureters were displaced accordingly with their respective kidneys. In no case was a ureter displaced in the absence of renal displacement, although lateral roentgenograms were not obtained in all cases. Ureteral displacement was characteristic in no way of any of the tumor types.

Metastasis: Wilms tumors metastasize at any time during their development, but metastasis is present in less than one-half of cases when first seen, according to Gross.[3] In only 2 cases in this series of 25 were there roentgenologically demonstrable metastases, these being multiple blood-borne nodular lesions of varying size in the lung parenchyma (Fig. 16). Such nodular lung metastases are characteristic of the Wilms tumor. The pulmonary lesions sometimes expand to involve the pleura. Metastasis to the pleura itself may also occur. In at least one-half of the 25 cases there was intra-abdominal extension of the tumor outside the bounds of the kidney or metastatic spread to other intra-abdominal organs; but, of course, these metastatic components could not be documented roentgenologically.

Skeletal metastasis occurs late in Wilms tumor. Campbell[11] mentions the spine, skull, scapula, and ilium as sites of metastatic bone involvement in his experience. Most authors agree, however, that skeletal metastasis in Wilms tumor is rare indeed. No case of osseous spread was present in our 25 cases. If bone metastasis is found on skeletal survey of a child with retroperitoneal tumor, the diagnosis of Wilms tumor should be seriously questioned.

The neuroblastomas metastasize by way of the lymphatic channels and the blood stream. Within the abdomen the liver is the most frequent secondarily involved organ, and in seven cases in our series massive hepatic involvement was noted at operation or autopsy. In only one of these cases could this hepatic involvement be confirmed by roentgenogram, in which diffuse flocculent calcification could be seen outlining a grossly enlarged liver.

Direct invasion of the renal parenchyma by a neuroblastoma arising in an adrenal gland or sympathetic ganglion near a kidney is not uncommon. Some of the pyelographic signs of intrinsic renal mass may thus be explained.

Extension of an abdominal neuroblastoma upward along the lymphatic channels or sympathetic nerve chain into the mediastinum is a natural route of growth. This occurred in two cases in this group and was clearly demonstrable on roentgenograms of the chest and abdomen.

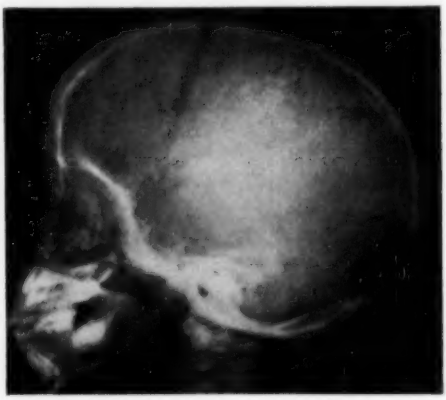
Fig. 17.—Generalized type of skeletal metastases of neuroblastoma involving pelvis (*A*) and extremities (*B*) in the same patient.

Statistically, the most frequent site of metastasis in neuroblastoma is the skeletal system. The long bones, especially the upper two-thirds of the arms and legs, the calvarium, ribs, and pelvis are most frequently involved. In 19 cases in this series in which the skeleton was surveyed, bone metastases were found in 9—7 of a generalized nature and 2 focal in type. The generalized metastases correspond to those described by Wyatt and Farber [14] as multiple small discrete and confluent areas of destruction with a small amount of proliferation of the surrounding bone. Periosteal proliferation at the site of the cortical metastasis is common, the periosteal new bone being formed parallel to the long axis of the shaft (Fig. 17). These lesions are confined mainly to the submetaphyseal regions of the long bones and may closely simulate the infiltration of leukemia; the lack of involvement of the metacarpal and metatarsal bones by the metastatic neuroblastoma, in contradistinction to the frequency of the latter finding in leukemia, is a differential point frequently mentioned.

The skull lesions are usually punched-out rounded foci of bone destruction unaccompanied by surrounding bone reaction. Often associated with calvarial lesions is spreading of the cranial sutures, indicating meningeal metastasis (Fig. 18), and destruction of the orbital walls by the neoplastic infiltration of the periorbital tissues.

Localized bone lesions of neuroblastoma are of a different sort, being purely destructive in type, and occurring in the distal diaphysis or metaphyseal margin. Two of our cases exhibited such localized bone metastases—one in the left radius only (Fig. 19), the other showed focal lesions in the left tibia and left humerus only. Fractures

Fig. 18.—Small "punched-out" neuroblastoma metastases to the tables of the skull. Diastasis of coronal suture indicates increased intracranial pressure secondary to intracranial metastasis of neuroblastoma.



through this type of lesion are reportedly common.

Chest roentgenograms were exposed in 11 cases of neuroblastoma, and no lung or pleural metastases were disclosed. In one of these patients, autopsy at a somewhat later date revealed metastasis to the lung tissue. This is a rare finding in neuroblastoma, and most writers agree that pulmonary lesions in this tumor occur as a terminal event and will usually be associated with the more common abdominal or skeletal metastases.

Fig. 19.—Focal type metastasis of neuroblastoma. Isolated, purely destructive lesion upper end left radius.

None of the five cases of retroperitoneal teratoma showed metastasis at operation or by roentgen studies of the chest and skeleton. Metastasis in these tumors is apparently rare. Lymph node metastasis and subsequent intra-abdominal recurrence occurred in one of Arnheim's [3] cases.

One group of cases not included in the analysis of the 23 examples of abdominal neuroblastoma should be mentioned. In these instances the patients were studied roentgenologically because of symptoms referable to the skeletal system. Widespread bone lesions suggestive of metastatic lesions of neuroblastoma were found. Bone marrow aspiration at a site of involvement yielded in most instances sufficient material for histologic diagnosis of neuroblastoma. In most of these cases, the primary site of the neuroblastoma was not sought by roentgen study or other diagnostic procedures, as it is well known that no patient with bone metastasis of neuroblastoma has recovered after therapy.

SUMMARY

Retroperitoneal tumors in infants and children are usually one of three types: (1) Wilms tumor of the kidney, (2) neuroblastoma, and (3) teratoma. The clinical and roentgen features of each, which may aid in their recognition and differentiation are listed as follows:

Wilms Tumor

1. Age about 3 years
2. Abdominal mass present
3. Hematuria may occur
4. Fever is present in one-half of cases
5. Hypertension in many cases
6. Mass visualized on plain abdominal roentgenogram
7. Calcification within tumor mass infrequent; when present it is of linear, peripheral type
8. Normal renal contour never present
9. Kidney displaced in any direction
10. Nonfunction of involved kidney in one-third of cases
11. Pelvis and calyces almost always distorted; pattern is "bizarre"
12. Metastasis to lungs and pleura; rarely to bone

Neuroblastoma

1. Age of patient usually between 1 and 2 years
2. Abdominal mass present
3. Hematuria absent
4. Fever infrequent
5. Hypertension unrelated
6. Mass visualized on plain abdominal roentgenogram
7. One-half of tumors show calcification; flocculent central deposits most common type
8. Normal renal contour present in one-half cases
9. Kidney displaced in any direction, but medial and cranial displacement rare

10. Nonfunction of kidney on involved side rare
11. Pelvis and calyces may be distorted; configuration may be indistinguishable from that of renal tumor; in many cases no pyelocalyceal disturbance
12. Metastasis to long bones, skull, pelvis, and meninges; lung metastases are rare

Retroperitoneal Teratoma

1. Patients under 1 year of age
2. Abdominal mass present—may be in midline of upper abdomen
3. Hematuria absent; bleeding from gastrointestinal tract possible
4. Fever infrequent
5. Hypertension unrelated
6. Mass visible on plain abdominal roentgenogram
7. Bone or tooth inclusion in mass characteristic
8. Normal renal contour
9. Kidney displaced in any direction, but lateral displacement of both kidneys is common
10. Nonfunction of kidney is rare
11. In most cases no pyelocalyceal distortion
12. Metastasis is rare

In way of differential diagnosis, entities such as hydronephrosis, solitary renal cyst, pancreatic cyst, and psoas abscess must be considered. If the various clinical and roentgenologic criteria for diagnosis of Wilms tumor, neuroblastoma, and retroperitoneal teratoma are adhered to, however, the separation of these nonneoplastic conditions from the tumors should be readily accomplished.

If the various clinical and roentgenologic features of retroperitoneal tumors in infants and children are considered carefully, an accurate diagnosis can be made in a high percentage of cases. Urographic study is particularly important in this respect, as has been emphasized.

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COMBINED USE OF CONTRAST MEDIA IN RETROPERITONEAL TUMORS

Critical Evaluation

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ASSOCIATED with the constant progress of medical therapy, there have developed newer, more accurate, and valuable techniques for diagnosis. This development is well exemplified in the field of retroperitoneal tumors. Tumors of this region may consist of adrenal cortex, medullary substance, or embryonal rests of adrenal tissue. The renal parenchyma and pelvis, as well as the ureter, produce the largest group of tumors in the retroperitoneal space. Neoplasms originating otherwise than from the above organs, but in the locale under discussion, may be any one of a great number of exotic tissue growths. These primary tumors [1] may arise from vascular, neurological, lymphatic, or muscular cytoplasm, or even from remnants of the embryonic urogenital ridge.[2] In addition, extravisceral retroperitoneal tumors may be present which are not neoplastic but are benign lesions, such as an aortic aneurysm or a cyst; extrarenal adrenal neoplasms may be metastatic in nature, but they may not be differentiated preoperatively from primary tumors of the retroperitoneal space by any of our diagnostic tools.

Several of the more precise tests listed in the Table, such as the arteriogram, the pneumogram, and the nephrogram, have been utilized by a limited number of clinicians for some time. With the present increased use of these tests, a number of means of effecting these procedures have been brought forth. I do not intend to discuss the multitude of techniques for production of these diagnostic studies, or their characteristics, because these matters are beyond the scope of this paper.

Because of our desire to extend to the limit the various roentgenographic studies of value in diagnosing retroperitoneal tumors, the staff of our clinic has attempted to utilize most of these procedures. We have used them singly and in combinations of two or more in an attempt to determine their advantages and disadvantages in establishing more accurate diagnoses in retroperitoneal lesions, whether or not they are tumors. Generally speaking, we have discontinued these combined contrast media studies because they are valueless, confusing, and technically more difficult to produce, there is greater risk to the patient, and thus they frequently cause loss of time, material, and money.

This paper was requested for this symposium on retroperitoneal tumors not so much for its value in only retroperitoneal tumors, but because it was felt by the officers of the radiology and urology sections that some limitations to the procedures presented by other members of this symposium be given. This paper, filled mainly with negative results, has been difficult to prepare without being unfair to all the procedures discussed. It is hoped that the repetitions presented will be understood. The various diagnostic procedures utilized by the clinician, if they can be combined with other procedures, will be discussed one at a time.

PYELOGRAPHY

Most of the procedures listed in the Table are commonly employed, and a discussion of their uses in various combinations would be foolish, as, for example, the combining of

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intravenous pyelography with retrograde pyelography. The value of pyelograms, intravenous or retrograde, in the study of retroperitoneal tumors, has been demonstrated by Greene.[3] The necessity for determination of anteroposterior diameters in the filming of pyelograms is an accepted and required procedure for accurate diagnosis of retroperitoneal tumors. Therefore, further discussion of these factors would be superfluous.

Procedures of Value for Roentgenographic Diagnosis of Retroperitoneal Tumors

Plain anteroposterior x-ray of the abdomen
Plain lateral x-ray of the abdomen
Plain oblique x-ray of the abdomen
Laminography
Intravenous pyelography
Retrograde pyelography
Retroperitoneal pneumography
Arteriography
Nephrogram
Barium enema
Cholecystogram
Upper gastrointestinal x-rays
Fluoroscopic visualization of the diaphragm

PNEUMOGRAPHY

Gas may be introduced into the retroperitoneal space by the lumbar route described by Carelli [4] or by the presacral route as described by Rivas.[5] This procedure permits gas infiltration around any structure or mass present in the retroperitoneal space. It has been found to be beneficial in outlining the kidney and the adrenal and pathological masses in the retroperitoneal fat. In our hands, retroperitoneal pneumography possesses its greatest diagnostic value in outlining the abnormally enlarged adrenal gland or pathological extravisceral retroperitoneal masses.

The two techniques for production of this diagnostic measure differ in that by the Carelli method only 200 to 300 cc. of air is introduced into the retroperitoneal space. The procedure of Rivas utilizes the presacral injection of from 600 to 1,200 cc. of air. Deaths have been reported from both techniques. The advocates of the presacral route of air injection claim greater safety by this method of gas insufflation. I have not been able to appreciate a greater safety factor, as claimed by its proponents. I find that the Rivas method requires from three to six times as much gaseous material as does the technique of Carelli. In our series of only slightly more than 100 cases studied by retroperitoneal pneumography, we have had 1 death. This was due to an air embolus in a case in which the Carelli method was used. In addition, bilateral ureteral obstruction resulting in anuria from the procedure by the technique of Rivas has been encountered. In my series I have found that this diagnostic aid has not been as safe as arteriography. Smith and co-workers [6] report over 100 cases in which they employed presacral pneumography without ill effects.

Retroperitoneal gas has not been demonstrated by us to be of specific diagnostic value in any particular renal lesion. Because fatalities have been reported from its use, it should be utilized only in delineating enlargement of extravisceral retroperitoneal masses. It is my feeling that introduction of gas into the retroperitoneal space should be employed only when by its use a procedure with greater mortality can be avoided; surgical exploration generally is not in the latter category.

The normal kidney or a renal organ with an associated mass, be it tumor or cyst, can be strikingly outlined by the introduction of gas around it. Differentiation of these masses into parenchymal neoplasms or cysts is not possible by the procedure. The combination of pyelography and perirenal gas may present an appealing contrast of the kidney on the x-ray (Figs. 1 and 2), but if not diagnostic the combination must be considered useless.

Gaseous outlining of the adrenal is of paramount importance in the roentgenographic diagnosis of adrenal masses. The increased size of the adrenal shadow revealed on the roentgenogram by the gas is beneficial in establishing the diagnosis. A pyelogram may reflect adrenal enlargement by displacement of the kidney. Schulte and Emmett [7] state that 72.5% of patients with extrarenal retroperitoneal tumors have displaced kidneys on

Fig. 1.—Combined perirenal air insufflation and retrograde pyelogram in suspected space-consuming lesion of the upper midportion of the kidney. The x-ray is appealing to the eye but not diagnostic.

the side of the tumor. Cahill and Robinson [8] state that adrenals may be seen on an ordinary film, or on an intravenous urogram, but that frequently the use of air insufflation best visualizes an adrenal tumor.

From this evidence it seems likely that combined pyelography and periadrenal gas may accurately demonstrate adrenal enlargement and renal displacement, if present. We have, however, never combined the two procedures, because we have not found such combination necessary. When adrenal enlargement is suspected, pyelography is essential as an initial study of the patient. Repeating the pyelogram at the time of gas introduction around the adrenal has never seemed to be valuable enough to add the additional risk of pyelography to the procedure. Arteriography, up to the present time, has not been shown to be of value in the diagnosis of adrenal tumors. Therefore, combining it with retroperitoneal gas for the study of adrenal masses is adding worthless complexity to an otherwise valuable, though risk-involved, procedure.

The third application of pneumography is in diagnoses of extravisceral retroperitoneal tumors, be they primary, metastatic, or benign lesions such as aberrant tissue, cyst,

Fig. 2.—*A*, proved renal-cell carcinoma of the upper pole of the right kidney. Retrograde pyelogram combined with presacral pneumogram. The perirenal gas reveals no masses. The pyelogram illustrates an upper pole space-consuming lesion. *B*, presacral pneumography and associated arteriogram. Note partial obliteration of the right renal artery. Note bilateral spotty, foamy, frothy appearance around the kidney. The arterial puddling and pooling of the upper pole of the right kidney have been obliterated, making interpretation of the film impossible.

or aortic aneurysms. These lesions may be delineated by retroperitoneal pneumography.

Such tumors are frequently attached to the kidney or displace it. However, pneumographic study is useless in differentiating primary tumors of the kidney from extrarenal masses attached to its surface. Pyelography in case of these extravisceral tumors demonstrates renal displacement. Pyelography in combination with extraperitoneal gas may manifest (1) a retroperitoneal mass in juxtaposition to the kidney or annexed to it or (2) displacement of the kidney by a mass. However, the two procedures singly or together do not identify whether the mass is renal or extrarenal in origin if the mass is in association with the kidney. An arteriogram and its associated nephrogram are the only measures advantageous to such differentiation. Little is to be realized from the combined studies that cannot be appreciated from pyelography and pneumography separately. The two procedures performed separately are easier for the patient and often prevent misinterpretation. The simpler the procedure, the less likely there is to be confusion, and, with this, is the decreased likelihood of necessity for repeating a diagnostic test.

ARTERIOGRAPHY

Arteriography originally described by Dos Santos [9] and first reported in this country by Nelson [10] and Doss,[11] is now established as a safe procedure.[12] The technique as described by Evans [13] and by Smith, Rush, and Evans [14] has likewise been found safe. We have now performed over 1,500 translumbar aortic punctures for arteriograms with insignificant morbidity and without fatality. The procedure is of proved value in the diagnosis of renal parenchymal tumors or cysts (Smith, Evans, Elsey, and Felson [15]). However, the arteriogram possesses no diagnostic arterial pattern in renal pelvic tumors unless they have extensively invaded the renal parenchyma. This diagnostic tool has, as stated, not been proved useful in the study of adrenal neoplasms. While we are lacking experience in its use in the study of extrarenal-adrenal tumors, it seems plausible that these neoplasms, if vascular enough, could be delineated.

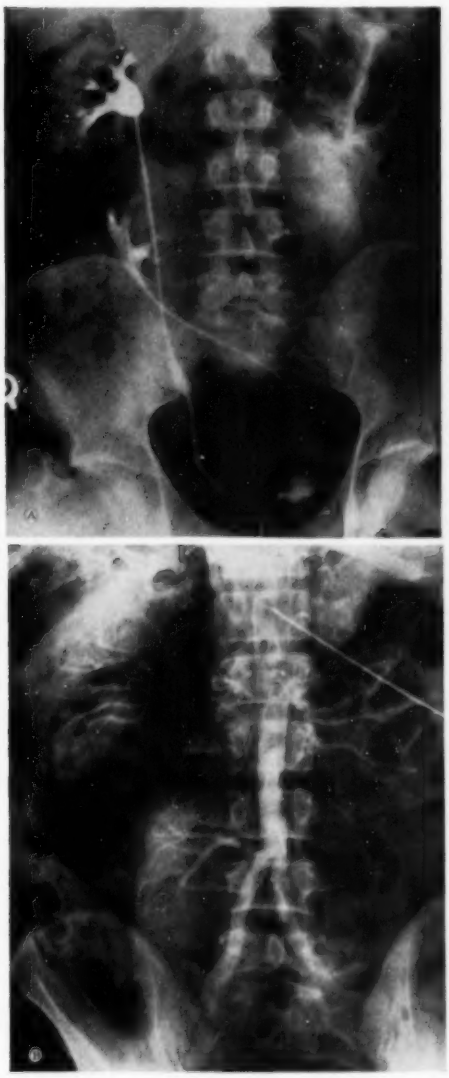
Initially, then, combining with any other study an arteriogram and its associated nephrogram would be of no value, and it would involve an added risk if arteriography alone does not possess diagnostic accuracy for the lesion in question.

The retroperitoneal tumors in which the chances of diagnosis by roentgenologic means might be enhanced by the combination of arteriography with another procedure are the renal parenchymal tumors and retroperitoneal, extravisceral masses. The feasible combinations are arteriography and associated nephrography with retroperitoneal gas or pyelography; the latter might be produced by either the intravenous or the retrograde method.

Because of the lack of adequate experience in the diagnosis of extravisceral retroperitoneal primary or metastatic tumors by the use of arteriography, we must resort to theorizing. Vascular tumors and aortic aneurysms may be illustrated by the combination of arteriography and gas insufflation. Arteriography accurately demonstrates the extent of the circulation of a particular kidney and therefore the quantity of its mass. In addition, it may demonstrate the same features of a tumor which is separate from the kidney in the retroperitoneal space. The pneumogram will outline the mass as being separated or joined with the renal structure. Several contraindications to combining the two procedures will be listed below. The nephrogram following the arteriogram definitely delineates the renal tubules from the extrarenal mass. We have studied one patient with a retroperitoneal mass attached to the kidney, a mass which was not of renal origin. In this case, by arteriograms, we were able to diagnose correctly a neoplasm of extrarenal origin attached to the kidney surface. The arterial pattern of this patient's lymphoma was not visualized. The arteriogram was not combined with another study.

Retroperitoneal air study does not differentiate renal cysts from tumors, and its use has therefore been replaced by arteriography

in our diagnostic armamentarium for renal tumors. Originally, in our examination of renal tumors, we combined pneumography and arteriography examinations in hopes of increasing the contrastivity of the arterio-



gram by perirenal air. This led to uninterpretable x-rays or inaccuracies because of two factors. One was the presence of a foamy, frothy, spotty appearance in many instances (Fig. 2) of the gas around the kidney. This, in turn, resulted in obliteration of the puddling and pooling as well as the irregular vascular pattern of a renal tumor and necessitated a repeat arteriogram. The other was the partial or complete obliteration of one renal artery (Fig. 3) and its accompanying intrarenal arborization observed in several cases. Before arteriography, we frequently performed simultaneous bilateral perirenal air insufflation; however, after a perirenal air insufflation we observed one case of bilateral renal artery obliteration with eight hours of anuria. There was no apparent reason other than bilateral renal artery com-

Fig. 3.—*A*, retrograde pyelogram of crossed, unfused right renal ectopia. *B*, perirenal air surrounding upper kidney obscures most of renal artery and obliterates much of the arterial pattern of the renal parenchyma. Normal-appearing renal artery and renal arterial arborization to the ectopic kidney, which has no surrounding gas. *C*, perirenal gas obstructs normal visualization of the nephrogram of upper kidney but not the ectopic kidney.

pression by perirenal gas. We have therefore discontinued the bilateral Carelli procedure. Rothfield, Hamm, and Harlin [18] state that by combining presacral gas insufflation with arteriography they found a valuable procedure. They fail to list the number of cases in which they utilized this combination; they listed no specific lesions in which it was

valuable, and they did not discuss the number of cases in which the combined procedures were not satisfactory.

Arteriography combined with either method of pyelography has been utilized by

us approximately 90 times. We have discontinued the use of intravenous urography combined with arteriography, because the greater the quantity of iodides given intravascularly the greater the possibility of fatality resulting. Our technique of arteriography was designed to utilize a minimum quantity of iodides. Dotter and Jackson [17] report, in a review of deaths from contrast media in angiocardiography, that the fatalities were more frequent when relatively large doses or multiple injections of contrast media were employed. Iodides are toxic. The smaller the quantity needed to obtain satisfactory diagnosis, the less is the patient risk. If pyelograms are required in combination with the arteriogram, the retrograde method seems the more logical to use.

By combining pyelography with arteriography, the most gratifying results are seen

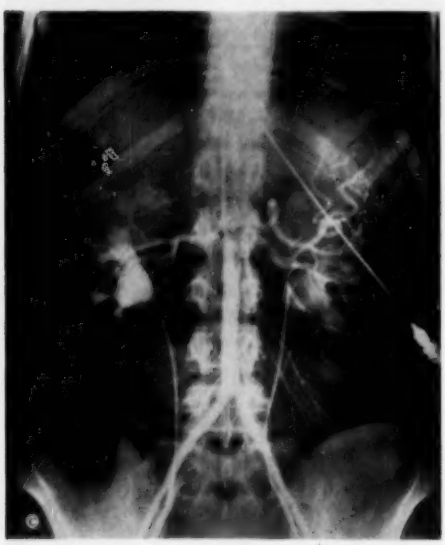


Fig. 4.—*A*, retrograde pyelogram combined with nephrogram demonstrates nicely the extent of the renal mass and the corresponding renal calyceal positions. *B*, normal, readily visible and interpretable renal arteriogram. *C*, Retrograde pyelogram combined with an arteriogram demonstrates the obliteration of much of the renal arteriogram by the pyelogram.

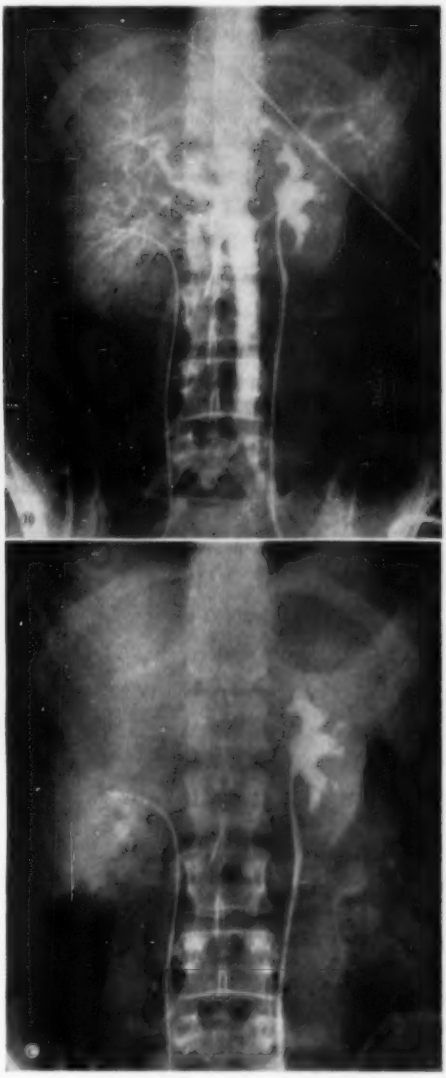
in the study of renal parenchymal tumors. These two studies combined, in such pathological changes, may produce a stimulating and exciting demonstration of a space-consuming renal lesion filled with an irregular vascular pattern and puddling and pooling of intravascular iodides (Fig. 4). Too infrequently, the pyelographic medium will

overlie part of the arterial pattern and cause obliteration of the arterial tree, producing an uninterpretable arteriogram. This is naturally a waste of time, money, and material and an added risk to the patient because it necessitates another anesthetic, another aortic puncture, and additional intravascular injection of the toxic iodides. If retrograde pyelograms are to be combined with an arteriogram in the study of renal parenchymal tumors, or any other renal lesion such as aberrant artery, the use of dilute pyelographic media is imperative. We use a 4 to 5% methiodal (Skiodan) sodium solution for these studies (Fig. 5).

Fig. 5.—*A*, bilateral retrograde pyeloureterogram. *B*, combined arteriogram and retrograde pyelogram. Three per cent contrast medium used for the right pyelogram, which does not cause arterial obliteration. Twelve per cent contrast medium utilized on the left. *C*, nephrogram and pyelogram combined.

The study of adrenal tumors by combined arteriography and pyelography is valueless, since neither procedure produces evidence of changes characteristic of an adrenal tumor. Pyelography, as stated previously, may demonstrate changed ureteral or renal position in extravisceral retroperitoneal tumors. An arteriogram may, on occasion, demonstrate the characteristic bizarre pattern of this type of neoplasm. However, little is offered by the combination of the two studies which cannot be realized by the procedures when done separately.

If, as previously stated, intravenous urography and arteriography are contraindicated, the diagnostician, in order to obtain combined arteriograms and pyelograms, must subject the patient to cystoscopy and retrograde ureteral catheterization. Both arteriography and retrograde pyelography



are formidable procedures for any patient to undergo on separate days, not to mention their combination on the same day. Because it has been previously shown that the combination of these studies has no demonstrable added value in the diagnosis of retroperitoneal tumors, why, then, should the patient be subjected to such procedures in order to obtain only an occasional "pleasing to the eye" x-ray?

SUMMARY AND CONCLUSIONS

A complete list of roentgenographic methods for diagnosis of retroperitoneal tumors has been presented. Some of the procedures listed present indirect evidence, others present pathognomonic x-ray changes of a particular retroperitoneal tumor, and in some lesions of this area an otherwise valuable roentgenological method is useless. Several of the procedures enumerated are not without risk to the patient and in certain cases might be of more risk to the patient's life than surgical exploration. It has been our experience that because of being desirous to obtain more accurate diagnosis, singly valuable procedures were combined. However, infrequently combinations of procedures can be called worthy of utilization in retroperitoneal tumors, and in fact, any retroperitoneal lesion. As a result of more thorough knowledge of the lesions in which each procedure is of value and can be used practically, I now employ the listed diagnostic measures in combinations very infrequently.

1908 Union Central Building.

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RADIATION THERAPY IN RETROPERITONEAL TUMORS

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THE MATERIAL for this article was collected over the years 1930 through 1953 at the Los Angeles Tumor Institute (Drs. Costolow, Meland, Johnson, Nolan, and Hare), and patients were referred by urologists and surgeons for postoperative radiation therapy. Seventy-three patients with retroperitoneal tumors were accepted for treatment. In some instances, the postoperative treatment was given immediately after surgery, and in others it was commenced only after recurrences or metastases had occurred. This caused a wide variation in the stage of disease, the tumor dosage, and the survival rate. With such diversity of cases, it is impossible to obtain survival percentages of statistical significance. It is our belief, however, that demonstrable regression of tumor and increased survival time after postoperative irradiation, or irradiation alone in the case of inoperable tumors, do demonstrate the value of these modalities. The widely varied origin and histology of these tumors make prognosis difficult. In many instances, response to irradiation cannot be determined until after adequate treatment has been given.

Fifty-two patients with renal tumors were treated with radiation therapy postoperatively. These tumors were classified as follows: adenocarcinoma 36, Wilms' tumor 10, sarcoma 1, and pelvic and ureteral carcinoma 5. In comparison with the studies done by Riches, Griffiths, and Thackray [1] on a total of 2,314 cases in the British Isles from January, 1935, to December, 1950, 75% were adenocarcinoma, 13.4% tumors of the pelvis and ureter, 8% Wilms' tumor, and 1.9% others.

	British	*Los Angeles Tumor Inst.*
Adenocarcinoma	75%	70%
Pelvis, ureter	13.4	10
Wilms' tumor	8	18
Others	1.9	2

RENAL AND URINARY TRACT TUMORS

In our series, of the 36 patients with adenocarcinomas, only 1 had preoperative irradiation. Sixteen patients were given routine postoperative irradiation to the tumor bed as soon as their condition would permit. The tumor dose averaged 2,200 r delivered in 32 days. For these 16 patients, the following survival times were obtained: 3 one year; 4 three years; 2 five years (1 of whom survived seven years).

Eight patients were referred for treatment six months or more postoperatively, who had had no immediate postoperative irradiation. Four had recurrences in the tumor bed or operative scar, and four had pulmonary metastasis. Those with local bed and scar recurrences received 2,400 r tumor dose in 26 days as an average. Three survived less than six months after completion of therapy, and one survived three years, having received two additional courses of 1,800 r tumor dose with Co^{60} teletherapy in 28 days. Four patients in this group received irradiation to the pul-

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monary metastasis, an average of 2,400 r (midlung tumor dose) with 250 kvp, 1.6 mm. Cu HVL, delivered in 26 days. There is no evidence that this prolongs survival time, one patient living less than 6 months, two over 6 months, and one surviving 18 months after completion of therapy. Seven patients were treated with radiation alone for inoperable adenocarcinomas; only one of them survived two years.

The foregoing supports the findings of Riches, Griffiths, and Thackray [1] in that a better survival is obtained with routine postoperative irradiation of the tumor bed in patients with adenocarcinoma of the kidney than in those patients who have had nephrectomy without subsequent irradiation.

Renal Adenocarcinomata

Years survived	1	3	5	10
Percentage treated with nephrectomy only	80	44	30	17
Percentage treated with nephrectomy and x-ray	86	53	49	27

Riches and his associates point out that size of the renal tumor at the time of operation has little bearing on survival, prognosis depending foremost upon the presence or absence of renal vein involvement, and, secondly, upon the histologic grading of malignancy.

Five of our patients were referred for postoperative irradiation after removal of a kidney and ureter for papillary carcinoma of the pelvis and ureter. One patient was alive with disease six months after completion of therapy. None survived a year after treatment.

WILMS' TUMOR, OR ADENOMYOSARCOMA OF KIDNEY

Preoperative irradiation for reduction in size of the large mass is of very doubtful value in Wilms' tumors. The large tumors have usually disseminated widely whether clinically obvious or not, and exploratory operation followed by irradiation alone will probably give just as good palliation and survival time as irradiation followed by surgery. Brown [2] and MacWhirter report 13 cases from the Royal Hospital for Sick Children prior to 1951, all operable patients with no metastases and all treated with surgery and postoperative irradiation. Of these, three survived—one four years and three months; one two years and five months, and one one year and one month. These patients were treated with 1,500 r tumor dose over a period of six weeks. The largest series of Wilms' tumors reported in the literature is by Riches, Griffiths, and Thackray.[1] Of 128 patients treated with nephrectomy and postoperative irradiation, with varying follow-up times, 10 were alive after three years (26%). Of 36 patients treated with radiotherapy alone, 3 were alive at one year (14%), and none survived for three years. Gross,[3] in reporting results of 69 cases at Boston Children's Hospital from 1931 through 1947, shows improvement from 32.2% in cures from surgery alone to 47.3% in those receiving postoperative irradiation to the renal fossa.

Of 10 patients referred with Wilms' tumor to our institution, 4 were treated for pulmonary metastasis following earlier nephrectomy and postoperative irradiation. These were given 1,500 r to the midlung in 26 days. One survived one year, and none survived three years. In two of these patients with widespread bilateral metastasis, later x-ray examination showed the lung fields to be entirely clear. Five patients were referred for radiation therapy alone owing to large masses and pulmonary metastasis, the masses receiving 2,000 to 2,400 r tumor dose in 26 days, and 1,500 r to the midlung in a like period. None survived one year. One patient was given routine postoperative irradiation to the tumor bed, receiving 3,000 r tumor dose in 100 days. This patient is alive and well today, 12 years after completion of therapy. There is no evidence of skeletal deformity or other radiation effects.

The prognosis in tumors of the kidney, whether adenocarcinoma or adenomyosarcoma, is dependent upon early recognition of the disease, prompt and complete surgical

removal, and immediate and adequate postoperative irradiation.

In the treatment of Wilms' tumor, tumor dosages in the range of 2,000 to 4,000 r have been used, usually delivered in 30 to 40 days. We consider 3,000 r tumor dose, in 30 to 40 days, adequate treatment. The treatment field should cover the entire abdomen to include both pedicles and the lymphatic drainage. In adults, tumor dosages in the midabdomen, of 5,000 to 6,000 r, in approximately 35 to 40 days, are tolerated, especially when radiation of the quality of gamma rays (half-value layer of 12 mm. Cu or more) is used. At present some patients are being treated by us with this technique. If the upper abdomen is included, the maximum dosage mentioned may not be obtained.

PRIMARY RETROPERITONEAL TUMORS

In the same period of time we treated in our institution 10 patients with primary retroperitoneal tumors, who were referred for treatment after exploratory procedures for biopsy. These cases were the following: sarcoma, undifferentiated 5; reticulum cell sarcoma 2; neurofibrosarcoma 1; fibrosarcoma 1; myxosarcomatous degeneration of lipoma 1—a total of 10.

The tumor dose varied from 2,500 r in 19 days to 5,200 r in 53 days. We feel that the entire abdomen should be covered, and if the patient's condition warrants it, a high tumor dose should be delivered.

In our 10 cases of primary retroperitoneal tumors (excluding the lymphosarcomata), the following survival times were obtained: 1 survived six months (undifferentiated sarcoma); 1 survived five years (myxosarcomatous degeneration of a lipoma), and 1 survived seven years (undifferentiated sarcoma).

Of 82 patients with lymphosarcoma, there were 11 patients (13.4%) with retroperitoneal mass and no evidence of peripheral involvement, the diagnosis having been made by exploratory laparotomy and biopsy. With this particular cell type, some of the most rewarding palliative results are obtained. Some patients in almost moribund condition when first seen will respond rapidly to irradiation and enjoy prolongation of a useful, comfortable life. An occasional patient will enter a leukemic phase and deteriorate rapidly. However, especially in this primary retroperitoneal tumor, irradiation should be offered for its palliative effects. The method of treatment for the retroperitoneal lymphosarcoma is the same as that for advanced, localized involvement in the peripheral form. Treatment should be initiated with smaller doses of 75 or 100 r (tumor) a day to avoid severe toxic reaction. Later the daily treatment is increased to about 170 r (tumor) daily to reach a total tumor dose of 3,500 to 4,000 r, unless multiple peripheral lesions develop or the patient's general condition dictates cessation of treatment at a smaller total dose.

With our 11 patients, tumor doses of 440 r in 10 days to 5,000 r in 46 days were obtained. The following survival times were obtained in the 11: 3 survived 1 year; 2 survived 2 years; 1 survived 5 years, and 1 patient survived 10 years, dying of a cerebrovascular accident. No autopsy was performed, although a laparotomy six years after treatment showed no evidence of disease.

SUMMARY

The prognosis of retroperitoneal tumors in general is similar to that of cancer in other parts of the body and depends upon early recognition, the extent of the growth, and prompt adequate treatment. The treatment of most operable retroperitoneal tumors is prompt and complete surgical removal combined with immediate adequate postoperative radiation. In extensive inoperable retroperitoneal tumors it has been shown in many cases that exploratory surgery with biopsy followed by adequate radiation therapy may result in definite palliation, and survival over several years may occur. The majority of retroperitoneal tumors are radiosensitive and will show some degree of response to proper radiation therapy.

We believe, from our own experience and from evidence in the literature, that the role of radiation therapy in the treatment of the majority of retroperitoneal tumors has been definitely established and that this modality should be employed routinely.

Evidence is rapidly accumulating which indicates that, with the newer techniques of radiation therapy made possible by the development of teletherapy, using radioactive applicators and x-rays of the quality of gamma radiation (half-value layer 12 mm. Cu or more), increased palliation and survival time may be achieved in these extensive, deep-seated cancers.

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SURGICAL TREATMENT OF RETROPERITONEAL TUMORS

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WE HAVE been interested in retroperitoneal tumors for a considerable length of time. In 1946 one of our former colleagues, Dr. B. A. Donnelly,[1] reported an extensive series from the University Hospitals, comprising 95 patients observed in a 20-year period.

Review of the material at the University Hospitals subsequent to Dr. Donnelly's report reveals some 32 cases in which an unequivocal diagnosis of primary retroperitoneal tumor can be made, excluding those of known adrenal, renal, and pancreatic origin and sacrococcygeal teratomata. It would appear, therefore, that in the University Hospitals patient population the incidence remains relatively constant.

How does a surgeon attempt to approach a retroperitoneal tumor with a reasonable chance for complete extirpation of the lesion at lowest risk to the patient?

Early in the course of the operative approach histologic studies should be performed by use of frozen sections. We believe that open preliminary biopsy can be dangerous, because of possible infection of the biopsy wound or by the spread of tumor in the abdominal wall or even in the free peritoneal cavity. While aspiration biopsy has appeared to be applicable to some neoplasms, it appears to have only limited applicability to retroperitoneal tumors. When it is employed, the use of the absorbable gelatin sponge (Gelfoam) "sandwich" technique is helpful.

The extent of the neoplasm should be gauged as accurately as possible prior to operation. What structures are involved? Final decision has to be established after the neoplasm is exposed and evaluated grossly, and usually by frozen section. This information may be weighed with precise knowledge of extent in determining the scope of definitive treatment to be performed. It would be redundant in this presentation to detail the various preoperative diagnostic studies that should be performed, but roentgenographic studies of the urinary and gastrointestinal tracts, plain film roentgenography, and, in many instances, angiography [2] are valuable adjuncts in determining both location and extent of the tumor prior to operation. Our experience with pneumography [3] has been principally in connection with adrenal tumors.

We feel that preparation for the operation should invariably include preparing the colon in the eventuality either that it will be opened or that a portion will be resected. For some time we have routinely employed a combination of oral succinylsulfathiazole (Sulfasuxidine) and terminal preoperative use of oral neomycin sulfate [4] in the preparation of the large bowel. Saline catharsis is employed, and just prior to operation the colon is thoroughly emptied with enemas. There are other preparations which should be mentioned and which should be considered as routine. The placement of ureteral catheters should be done on the morning of operation.

Special vascular instruments should be available, including clamps for interruption of the aorta, vena cava, and other large vessels. Preparation for replacement of large vessels should be considered, with either fresh aortic homografts for freeze-dried aortic homografts available. Careful pre-

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operative preparation must be made for the possible use of massive blood transfusion. Equipment should be available to replace the blood by the intra-arterial route in the event of catastrophic hemorrhage. Serious peripheral ischemia may be associated with the introduction of large volumes of cold bank blood into peripheral arteries, such as the radial. On several occasions we have employed direct intra-aortic transfusion, with heartening success. In our recent series (1946-1954), the average amount of blood used was between 5 and 6 pt. (2,355 to 2,838 cc.) in those instances in which definitive resection was performed. Occasional cases will be encountered in which much more blood will be required.

We have preferred the use of general anesthesia with endotracheal intubation. We consider this safer with the patient in side-lying and prone positions.[5] If the use of electrocautery is contemplated, one must make sure that the gaseous anesthetic agent is compatible in terms of explosion-hazard.

If one is to epitomize briefly what is to be said about incisions, it must be stated that above all they must be generous. We prefer transverse or oblique incisions for reasons of generally better exposure and mechanically sounder postoperative status of the abdominal wall. For high lesions, one should be prepared for combined thoracoabdominal approach. We have recently found this preferable in therapy of some adrenal tumors. When we apply the thoracoabdominal approach, we generally resect rib rather than make an intercostal incision. The diaphragm as well as the pleura is usually opened. We employ the usual techniques in terms of maintenance of postoperative pleurodynamics with the use of one or two thoracotomy drainage tubes of firm rubber led off under a water-seal trap.

For several years we have employed neurosurgical silver clips to delineate boundaries of neoplasm in the event that subsequent x-ray therapy is necessary. If possible, we prefer to have the radiotherapist come in and witness the gross findings in the event his subsequent services are employed. We have not had personal experience with the use of vital dyes, such as Direct Sky Blue, 4%, but they have a place in demonstrating routes of lymphatic metastasis under some conditions.[6]

What sacrifices of contiguous structures can one make and still have an operation compatible with life and function? In other words, what is the absolute extent of operation? One should say in terms of dealing with the retroperitoneal structures that the superior mesenteric vessels and the celiac axis represent territory allowing little trespass. From a theoretical standpoint, the aorta may be resected immediately inferior to the emergence of the superior mesenteric artery to include the renal arteries, with substitution by homotransplant. The surgeon must constantly bear in mind the necessity of evaluating the critical arterial areas before any irreversible steps are made. Certainly one kidney, the entire pancreas, a large portion of the liver, and any reasonable portion of the gastrointestinal tract may be removed.

Hemostasis is frequently a trying problem. Electrocautery is occasionally very useful. Diffuse oozing is frequently troublesome. The use of bovine thrombin [7] and absorbable gelatin sponge [8] is of aid. Difficulties in hemostasis are reduced if the surgeon is successful in establishing natural cleavage planes.

We prefer to close the wound with interrupted sutures of nonabsorbable material. There are no absolute rules in relation to the use of drainage, but, owing to the frequent incidence of large dead space, the problems of oozing, and, occasionally, factors of contamination, there is frequent indication for employment of soft rubber drainage.

The elements of postoperative care are not peculiar to this class of neoplasm. If any generalization is permissible, it might be stated that the incidence of inhibition-type ileus is rather high. We prefer to use nasogastric suction until there are normal peristaltic sounds. The decision of how long to leave the ureteral catheters in place after operation is one which will have to hinge upon whether there has been concomitant damage to the urinary tract. Early ambula-

tion is encouraged. Adequate replacement of blood volume, careful attention to lower extremity movement, and, possibly, early ambulation all contribute to lowering the incidence of postoperative venous thrombosis and embolism. Because these operations are frequently extensive and involve the gastrointestinal tract, special problems in relation to fluid and electrolyte balance are often posed. Every effort should be made to restore and maintain normal blood volume and to assess in the early postoperative period where the patient stands in relation to this matter. The question frequently arises in regard to when to begin x-ray therapy if combined therapy is to be employed. In general, we have found that the patients tolerate it better if there is at least a short period of normal gastrointestinal tract function prior to the institution of x-ray therapy.

Tables 1 and 2 demonstrate our results. In our recent series only 10 out of 31 lesions could be grossly excised. One must generalize that the results of surgical extirpation are poor except in benign lesions and, from our experience, there are relatively few long-term survivors. A question is frequently raised: What benefit is there in partial removal of a retroperitoneal tumor? We feel that in partial removal there may be occasional striking palliation with the benefit hinging principally on mechanical factors. If the surgeon is armed with precise information in regard to the type of tumor with which he is dealing, he will be wisely guided in relation to how radical to be in noncurative procedures. The prognosis hinges on the type, location, and extent of the tumor. Reference is made to this in Table 3. In looking ahead, there are perhaps short advances

TABLE 1.—*Treatment*

	1925-1946	1946-1954
Size of series	95	22
Ratio of resectable cases	34 of 82 (41.5%)	10 of 31 (32.3%)
Complete excision and no x-ray	21 of 34 (61.8%)	7 of 10 (70%)
Treated with surgery and deep x-ray	13 of 34 (38.2%)	3 of 10 (30%)
Operative mortality	19.7%	6.3%

TABLE 3.—*Histologic Types of Primary Retroperitoneal Tumors Treated at the University of Iowa Hospitals 1946 to 1954*

Malignant

Type	Cases No.
Malignant lymphomas	10
Mixed type	4
Lymphocytic	2
Reticulum cell	2
Lymphoblastic	1
Giant follicular type	1
Sarcomas	9
Fibrosarcoma (neurogenic)	3
Fibrosarcoma (angioblastic)	3
Myxosarcoma	2
Fibrosarcoma	1
Other types	11
Undifferentiated neoplasms	8
Neuroblastoma	1
Embryonic carcinoma	1
Fibrolipoma (low-grade malignancy)	1
Total	30

Benign

Type	Cases No.
Retroperitoneal cyst	1
Neurofibroma	1
Total	2

TABLE 2.—*Results of Treatment*

	1925-1946	1946-1954
Of the 21 treated by excision	4 died postoperatively 4 died, living average of 24 mo. 10 lived average of 46 mo. postoperatively (at time of publication) 3 no follow-up	0 died postoperatively 2 died, living average of 12 mo. 5 still living average of 57 mo. postoperatively
Of the 13 treated by combination of surgery and x-ray	3 lived at least 1 yr. 2 lived average of 33 mo. 7 still alive at time of publication 1 recently discharged at time of publication	Of the 3 treated by excision and x-ray: 2 died—living average of 23 mo. 1 still living 13 mo. postoperatively

possible in radicalism of operative approach. In rare instances there may be grafting of segments of the aorta and its principal branches. Sustained hypotension and hypothermia possibly offer help in selected instances.

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APPENDICITIS

A Fifteen-Year Survey

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IN 1949, a 10-year survey of the treatment of appendicitis in St. Joseph Mercy Hospital, Ann Arbor, Mich., was published.[1] For comparison, that report was divided into two five-year periods, 1935 to 1939 and 1940 to 1944. A considerable improvement in the over-all mortality, from 2.6 to 1.1%, was noted. The variable factors were considered, and sulfonamides available during the second period were given the greatest credit, inasmuch as postoperative peritonitis had been greatly reduced. It is the purpose of this report to add a third five-year period, 1947-1951, which was notable in that penicillin and certain other antibiotics became readily available and the mortality reached a figure which is probably the irreducible minimum. This remarkable reduction in the mortality has been noted recently by other authors.* Although this great improvement has been made, there are still problems in the treatment of appendicitis that warrant discussion.

In this study are included the cases of all patients treated for appendicitis or for whom an appendectomy was done as a primary operation, during this 15-year period. The vast majority of the patients came from the local area and must be considered as private patients treated in a small private hospital, in contrast to the groups of patients often studied from large charity hospitals.

During this 15-year period (1935 through 1944 and 1947 through 1951), 3,277 patients were treated for appendicitis. This comprised 8% of the major surgery done during this period. Of this total group, 1,196, or 36%, were treated by an interval appendectomy. There was a marked but unexplained drop in the incidence of the interval appendectomy during the third five-year period. This latter group will not be mentioned again except in the correlation of the clinical picture and the pathologist's report. In all, 2,071 were treated for suppurative appendicitis, but of these 413 either had no microscopic evidence of suppuration or another disease was found at operation. Therefore, 1,658 cases were correctly treated for suppurative appendicitis.

During the first 10-year period, six surgeons did 95% of the surgery. During the third five-year period, six did 96%, there being two losses and two replacements on the staff. Also during the third five-year period an intern-resident training program was established, with good results.

All operative material was examined by the pathologist. "Simple acute appendicitis" constitutes the bulk of cases in any survey that includes all types of appendicitis; yet very few authors define what they have included in this classification. The classification of simple acute appendicitis must be based, not on the operator's impression, but on the pathologist's report. Unfortunately, this basis can be so broad as to be meaningless if the language of the pathologist is not properly evaluated. Many surgeons firmly believe that mechanical factors, such as fecaliths and constricting bands, can be the cause of abdominal pain severe enough to warrant emergency surgery. However, as in the previous report, for this additional five years the only cases included as proved appendicitis are those which were reported as "suppurative appendicitis with purulent exudate in the lumen and pyogenic infiltration of the wall." This eliminates those reported as catarrhal appendicitis, lymphoid hyperplasia, active chronic appendicitis, mechanical appendicitis, and others. In comparison with

* References 2, 3, 4, 5, and 6.

criteria in many other reported series, this is a very severe criterion and may be questioned. Undoubtedly our high percentage of error in diagnosis is influenced by this classification, but it sharply divides the proved case from the doubtful case, and leaves the proved case beyond doubt.

As in the previous report, the cases have been classified as shown in Table 1. Because peritonitis often occurs without gross rupture of the appendix, no separate classification of ruptured appendix has been made. The mortality for simple acute appendicitis has been near zero for many years. Therefore much effort has been expended to reduce the number of complicated cases of appendicitis. Improved mortality statistics have been attributed to such a reduction. Unfortunately, peritonitis with or without rupture of the appendix has frequently been reported within six to eight hours of the onset of symptoms. During the 15-year period, the percent of patients seen within 24 hours of the onset of symptoms increased from 63% to 73%, and the percent of those waiting over three days or more decreased from 16% to 8%. Yet we regret to say that in these three five-year periods studied, the percentage of complicated cases, although varying considerably, has not shown any appreciable improvement. Other authors have reported a marked reduction in the percentage of complicated cases seen in recent years.[7]

The use of chemotherapy and the antibiotics to control infection has been so conclusively shown to be the constant factor in reducing the mortality rate that many of the points of previous controversy are now of historical interest only. The use of good surgical techniques and sound surgical judgment still remains most important. Many factors previously considered important can now be mentioned only briefly. The right rectus incision has been largely abandoned for a muscle-splitting incision in the right lower quadrant. Generally speaking, the anesthetic of choice may be considered to be the anesthetic best administered by the anesthetist available.

The influence of age upon the mortality and morbidity of appendicitis has been well described. Undoubtedly the irreducible mortality will center around the problems of surgery in the very young and in the aged.

The conservative treatment or immediate operation for generalized peritonitis and appendiceal abscess was formerly a matter of great divergence of opinion. In this hospital, appendicitis with localized peritonitis was, with few exceptions, considered a surgical emergency, and so treated. In the previous report of 10 years' experience, the impression was gained that conservative treatment should have much credit for the lower mortality in cases of abscess or generalized peritonitis. Our case numbers are too small to be of statistical importance, as indicated in Table 1. With the present availability of antibiotics, certainly no one would consider emergency surgery for appendiceal abscess. There were no fatalities during the second five-year period with chemotherapy, and antibiotics controlled seven of nine patients so treated during the third five-year period. All seven returned for an elective appendectomy. As in the previous 10 years, the diagnosis of appendiceal abscess was difficult. Six

TABLE 1.—*Classification with Results of Treatment*

	1935-1939			1940-1944			1947-1951		
	Cases	Deaths	%	Cases	Deaths	%	Cases	Deaths	%
Simple acute appendicitis	308	1	0.32	463	None	0	353	None	0
Appendicitis with localized peritonitis	77	4	5.2	113	4	3.5	127	1	0.7
Appendicitis with generalized peritonitis	9	2	22	18	3	14	9	1	11
Appendiceal abscess	23	4	17.3	28	None	0	15	None	0
Totals	417	11	2.6	622	7	1.1	504	2	0.4

of the last 15 cases were not so diagnosed preoperatively. These patients not properly diagnosed uniformly had a stormy postoperative course. The treatment of generalized peritonitis of appendiceal origin is still a matter of opinion requiring the proper interplay of surgery and the use of antibiotics.

The question of when to drain the abdominal cavity has long been a subject for discussion. There has been a great change in thought but drainage still has a place, as secondary intra-abdominal abscesses may occur despite antibiotics. In our series of 1935-1939, of the cases of simple acute appendicitis 36% were drained, 3% in 1940-1944, and none in 1947-1951. Of the cases of localized peritonitis, 91% were drained in 1935-1939, 50% in 1940-1944, and 21% in 1947-1951. This lack of intra-abdominal drainage has been well tolerated, as only six intra-abdominal abscesses occurred in the last five-year period, two despite drainage, but in no instance was a secondary surgical drainage necessary. The trend would seem to be to eliminate drainage of the abdominal cavity. Wound drainage alone was more widely used. The incidence of wound infection is actually unknown, as many of these infections occurred after the patient left the hospital.

With the advent of chemotherapy and then the antibiotics, there was need for careful evaluation of their effectiveness. However, as each new wide-spectrum antibiotic is now made available, previous experience seems valid for the treatment of peritonitis or abscess. Overtreatment, sensitization, and needless use of antibiotics are now the pertinent problems. I report with marked concern that 36% of 353 cases of simple acute appendicitis received antibiotic therapy. The mortality and morbidity was little different in this group as compared to the similar groups receiving chemotherapy alone or receiving neither chemotherapy nor antibiotics. The increased cost to the patient and the loss of future effectiveness of the antibiotic through sensitization must be realized by the attending physician. The use of antibiotics for peritonitis and abscess needs no defense. During the third period studied, 1947-1951, penicillin in its various forms was used in the majority of cases, chlortetracycline (Aureomycin), streptomycin, chloramphenicol (Chloromycetin), and combinations were used sparingly. The technique of the use of antibiotics needs no comment here.

Although many aspects in the treatment of appendicitis are now largely of only academic interest, the problem of the diagnosis of acute appendicitis is more important than previously. Of major operations done in all types of hospitals, appendectomy is by far the commonest. Because of the present publicity concerning "unnecessary surgery" and "unethical surgical practices," the emergency appendectomy must be carefully scrutinized. In many parts of the country, a patient need only complain of discomfort in the right lower quadrant to find himself the victim of an emergency appendectomy done in the middle of the night. The American College of Surgeons has advised that "tissue committees" be formed to investigate the number of "normal appendices" removed as emergencies. The American Medical Association has appointed a committee to study the causes of unethical practice. In a separate communication the problems of a tissue committee in screening the results of emergency appendectomy will be discussed. One basic problem is what diagnosis made by the pathologist will be considered as confirming the clinical diagnosis of acute appendicitis. As stated elsewhere, for this study we have made the pathologist's diagnosis of "suppurative appendicitis with purulent exudate in the lumen and pyogenic infiltrations of the wall" mandatory to confirm the clinical diagnosis of acute appendicitis. Many authors have been satisfied with far less evidence of pathological change. Considering the vast literature on appendicitis, there are relatively few articles dealing with this aspect. Accordingly, the reported range of error in diagnosis is from 4% to 40%. My percentage of error is 20.6% as shown in Table 2. Although the clinical history, physical signs, and laboratory data pertinent to the diagnosis of acute

TABLE 2.—*Accuracy of Diagnosis* *

	1935-1939	1940-1944	1947-1951
Proved appendicitis	526	730	496
No appendicitis	93	93	96
Proved other disease	16	23	42
% error	20.7%	15.8%	21.7%

* All cases operated on as emergency.

appendicitis have been many times listed, it is the composite picture that makes the diagnosis possible. A reasonably typical picture has been reported in as low as 61% and as high as 90% of the cases proved to be appendicitis.[8] In my first report, it was felt that 81% of those operated on had a typical picture of acute appendicitis. In the third five-year period, 75% had a typical picture. In the group operated as emergencies but for whom no suppurative appendicitis was reported, 71% of the 15-year survey had a reasonably good clinical picture of acute appendicitis. It is in this group that one finds the "Disease X." That disease is characterized by the history of generalized abdominal pain localizing to the right lower quadrant, nausea and vomiting, a well elevated white blood count, slight elevation of temperature, and a normal urine. Physical examination reveals tenderness and spasm in the right lower quadrant. Abdominal exploration reveals no pathology; the pathologist reports recurrent appendicitis slightly active, and the patient, relieved of his complaints, will sit up in bed next morning and demand breakfast. This course of events takes place often enough to make any critical observer seriously question what was the disease so successfully treated by appendectomy. In considering the error in diagnosis of acute appendicitis, "Disease X" merits consideration.

The penalty of the missed diagnosis has been often emphasized. Table 3 shows those

TABLE 3.—*Patients Operated on with Other Diagnosis or After Long Delay in Making Diagnosis of Appendicitis*

	1935-1939	1940-1944	1947-1951
Cases	26	56	11
Deaths	2	2	1
Very difficult course	2	2	4

patients whose preoperative diagnosis was other than appendicitis or for whom the diagnosis of appendicitis was not made until the hospital course made this evident. The seriousness of this delay is obvious from the five deaths reported. Although this group represents only 5.6% of the total of proved cases, it is toward this group that attention must be focused to reduce mortality. Boyce [9] has remarked upon the increase in the incidence of atypical appendicitis. In the doubtful case of acute appendicitis, authors have recommended further observation, repeated laboratory studies, and consultation. However, the fear of rupture during such delay is a very real factor in the decision for surgery. Such delay was practiced infrequently during the first 10-year period, but during the third 5-year period, 111 patients were admitted to

TABLE 4.—*Patients Observed and Then Operated on for Appendicitis 1947-1951* *

Suppurative appendicitis found	60
No appendicitis found	42
Another disease found	9
	111

* Delay harmful to 2.

the hospital with the presumptive diagnosis of acute appendicitis. They were observed for an average of 36 hours and then operated with the diagnosis of continuing appendicitis. Table 4 shows the result. These 111 cases, forming 6.6% of the total treated, represent the conservative attitude toward emergency appendectomy. Of this group so observed, two patients undoubtedly had a much more severe postoperative course owing to this delay, but there were no deaths, and free rupture of the appendix did not occur. Therefore, it would seem that observation may be safely carried out in the doubtful case. The differential diagnosis between acute appendicitis and other abdominal diseases has often been described. Table 5 shows the other diseases found at operation. As usual, the pelvis in the female leads in the deception. Probably 14 of the 81 cases required emergency surgery for the proper care of their disease; therefore, although the diagnosis of

appendicitis was in error, the patient received the proper treatment. This group of 81 cases, 4% of the total treated, is probably representative of the problem of differential diagnosis.

To further confuse the relationship between the clinical diagnosis and the pathologist's report, 13.7% of those appendices removed at an interval appendectomy were reported to have "acute suppurative appendicitis"—a reversal of "Disease X."

As stated before, the emergency appendectomy needs careful consideration in view of the charges of unnecessary surgery. Although individual variations are to be expected, surveys should be done so that an acceptable range of error can be established. With this information the results of staff audits could be evaluated.

eliminated. One of the two deaths in the third five-year period was due to a cerebral vascular accident in an elderly woman recovering from her surgery. The second death listed as due to generalized peritonitis occurred in a patient who had been treated in another hospital for four days. The family demanded transfer, as her condition was critical, and the diagnosis was in doubt. After 24 hours of preparation, laparotomy was performed for either a ruptured appendix or a small bowel obstruction. The former was found, with free feces in the peritoneal cavity. She died shortly thereafter. In all large series of unselected cases there will always be a certain mortality rate owing to the dangers inherent in any surgical operation and also due to the undiagnosed case. Even so, this is a dramatic change from the reports

TABLE 5.—*Other Diseases (1935-1939)—Not Appendicitis (1947-1951)* *

Pelvic		Genitourinary		Gastrointestinal		Miscellaneous	
Ruptured follicle	25	Stone or infection	6	Meckel's diverticulitis	4	Perforated cecum	1
Salpingitis	16	Sulfonamide crystalluria	1	Cholecystitis	6	Carcinoma of appendix	1
Pregnancy	2	Hydronephrosis	1	Sigmoid diverticulitis	4	Terminal ileitis	1
Endometriosis	1	Perirenal abscess	1	Mesenteric adenitis	4	Hematogenous peritonitis	4
				Volvulus of ileum	1	Toxic psychosis	1
						Peritonitis after chicken pox	1
	44		9		19		9

* Total—81 cases—4% error. All operated on as emergency for appendicitis.

TABLE 6.—*Causes of Death*

	1935-1939 526 Cases	1940-1944 730 Cases	1947-1951 504 Cases
Generalized peritonitis	9	3 *	1
Age and cardiovascular disease	1	5	1
No diagnosis	1	1	0
Undrained subphrenic abscess	0	1	0
Pulmonary embolism	0	1	0
	11	11	2

* Two patients moribund on admission.

The mortality rate expressed as the overall rate or expressed as the rate for each classification of appendicitis has long been considered the measure of success of the treatment. This series and others recently reported would indicate that the irreducible minimum has been reached. Table 1 shows this experience over 15 years, and Table 6 shows the causes of death. As stated before, peritonitis and its sequelae have been almost

of 10 or 15 years ago.† There is no question but that the control of infection by the antibiotics is largely responsible for this change. Despite the use of antibiotics, appendicitis, certain reports notwithstanding,[12] is still a surgical disease requiring careful consideration of the diagnosis and constant application of good surgical principles.

SUMMARY

A 15-year report (1935 to 1944 and 1947 to 1951) is given concerning the treatment of appendicitis at St. Joseph Mercy Hospital, Ann Arbor, Mich. During these periods a total of 3277 patients were treated primarily for appendicitis. Of this total, 36% underwent an interval appendectomy. Of 2071 patients 64% were operated for suppurative

† References 10 and 11.

appendicitis but of these, 413 either had no microscopic evidence of suppurative appendicitis, or another disease was found. This error in diagnosis was 20.6%. A very exacting criterion was used from the pathologist's report to confirm the clinical diagnosis of appendicitis. The mortality showed a marked improvement in each five-year period, dropping from 2.6% to 1.1% to 0.4%. The latter is considered the irreducible minimum to be expected in any series of major operations. The usual factors long considered to affect the mortality have been only briefly discussed, as the control of infection by the antibiotics is the main factor in this improvement. However, emphasis is again placed on accurate diagnosis, prompt hospitalization, and good surgical judgment.

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ANASTOMOSIS OF RENAL TO SUPERIOR MESENTERIC ARTERY

Resection of Lesions Involving the Proximal Superior Mesenteric Artery

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SOME BRANCHES of the abdominal aorta cannot be interrupted without hazard except under unusual conditions. Among these vessels are the superior mesenteric artery and the hepatic artery distal to the origin of the gastroduodenal. If such an artery is injured or is intimately involved by an otherwise resectable tumor, removal of the arterial segment concerned may be fatal. However, to do nothing in a case of this type will probably give an equally dismal result. Hence any dependable method allowing such arterial segments to be bypassed and the arterial blood supply to vital organs preserved may find application.

In 20 dogs, ranging from 11 to 20 kg., a left subcostal incision was made with the subject under ether anesthesia and the viscera were retracted to the right. This gives excellent exposure to the superior mesenteric artery and celiac axis, whose origins lie close together at the base of the mesentery (Fig. 1), and there are no major veins to interfere with easy isolation of the first 2 to 3 cm. of the artery. The superior mesenteric artery or celiac axis was divided near its origin from the aorta and the proximal cut end was tied. In six dogs the distal cut end of the superior mesenteric was then anastomosed directly to the ventral surface of the abdominal aorta below the origin of the renal arteries (Fig. 2). In all anastomoses a continuous over-and-over suture of 6-0 oiled nonabsorbable surgical silk was used. All six of these dogs died within 48 hours with thrombosis at the anastomosis and infarction of the small intestine.

One factor which may have contributed to these failures was the tension on the anastomosis, which is hard to avoid if the origin of the superior mesenteric artery is transplanted more than a few centimeters down the aorta. Another was the inevitable alteration in the angle of origin of the superior mesenteric artery from the aorta from obtuse to acute. It seems logical that increased work must be done and greater turbulence of flow produced as the angle of origin of a vessel becomes more acute and as the blood flow changes direction more markedly where it leaves the parent vessel.

In 10 dogs the left kidney was removed and an end-to-end anastomosis performed between the left renal artery and the distal cut end of the superior mesenteric artery (Fig. 3). In four dogs the same procedure was done except that the celiac axis was divided and the blood flow reestablished by joining its distal cut end to the renal. Seven of these dogs survived and remained in good health until killed 17 to 98 days after operation. Seven died in the early postoperative period and their survival times and causes of death appear in Table 1. One of these died of intra-abdominal bleeding, probably not from the suture line. Six had thrombosis of the anastomosis. This resulted in gangrene of the small bowel in four cases and of the stomach in the one in which the celiac axis was used. Dog 133, however, died of distemper and had a perfectly viable intestine at autopsy despite a clot in the anastomosis.

It is of interest that of a total of 11 dogs dying of thrombosis and ileal or gastric infarction, 9 died within 48 hours, but 2 died

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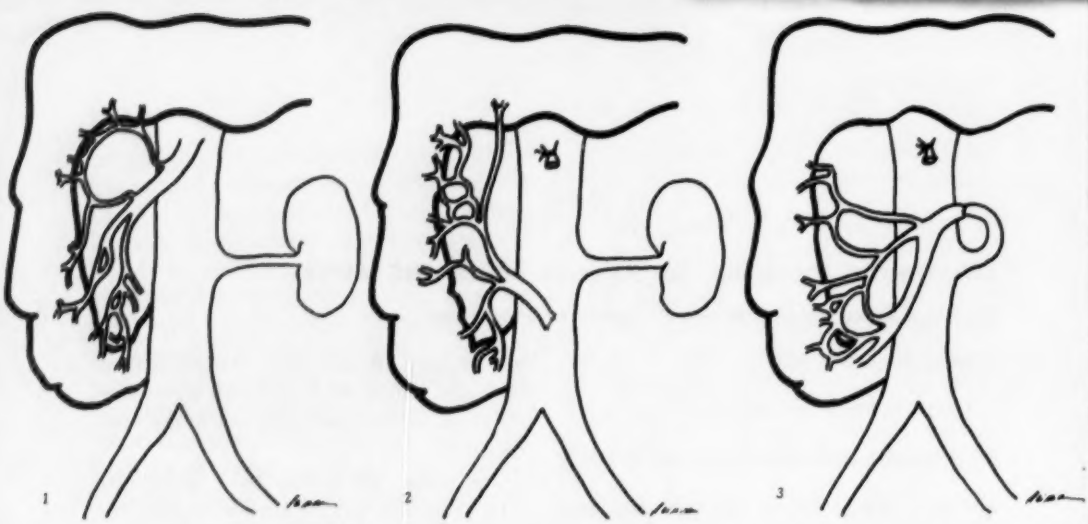

Fig. 1.—Diagram showing normal anatomy as exposed after intestines are retracted to dog's right.

Fig. 2.—Diagrammatic representation of procedure performed in first six dogs.

Fig. 3.—Diagram of procedure performed in 10 dogs. In four others the renal artery was anastomosed to the celiac axis.

five and seven days after surgery, respectively. These animals were not given antibiotics and so could not have long survived frank bowel gangrene. Moreover microscopic examination of the thrombus in Dog 923, who died five days postoperatively, showed a fresh clot with no connective tissue ingrowth. We must conclude, therefore, that fresh thrombosis can occur with fatal results at least as long as five to seven days after the anastomosis was made.

Table 2 summarizes the findings in the seven dogs who survived the early postoperative period and were killed later. In one of these, Dog 72, the anastomosis was closed by an old firm pale organized thrombus, but here again, as with Dog 133, there was no abnormality of the small bowel. In five of the killed dogs the anastomoses were examined and found patent, and in the sixth (Dog 856) it was probably so, although autopsy confirmation from examination of the vessel was not obtained.

Microscopic examination of five of these anastomoses was performed, two being patent (Dogs 971 and 922), two containing recent thrombi (Dogs 923 and 858), and one being closed by an old thrombus (Dog 72). In every case the reaction about the 6-0 surgical (silk) sutures was minimal, consisting of early slight intercellular edema and lymphocytic infiltration and of increased density of surrounding collagenous tissue and rare giant cell formation in later stages. This reaction certainly was not sufficient to be a significant factor in promoting thrombosis. Local inflammation also appeared unimportant, the only sign of it being moderate

TABLE 1.—*Findings in Seven Dogs Who Died Soon after Left Renal to Superior Mesenteric Artery or Celiac Axis Anastomosis.*

Dog	Survival, Days	Status of Anastomosis	Cause of Death
883	1	Patent	Intra-abdominal bleeding
979	2	Thrombosed; two left renal arteries	Infarction of stomach and liver; renal to celiac axis anastomosis
52	7	Thrombosed	Infarction of ileum
858	2	Thrombosed; two left renal arteries	Infarction of ileum
923	5	Thrombosed	Infarction of ileum
78	2	Probably thrombosed	Probable infarction of ileum; no autopsy done
133	6	Thrombosed	Distemper; intestine viable

lymphocytic and mononuclear cell accumulation on the outer surface of the suture line in several instances.

Thirteen dogs developed thrombosis at the anastomosis but in only 11 was death due to gangrene of the viscus supplied by the thrombosed artery. Two (Dogs 72 and 133) survived thrombosis of a left renal to superior mesenteric artery anastomosis without any gross damage to the ileum. Our observations here confirm those of Hurwitt, who found that acute ligation of the superior mesenteric artery in the dog is not invariably fatal. The obvious corollary is that survival after an operation on this vessel is not conclusive evidence that its blood flow remains intact; the anastomosis itself must be examined. Findings such as the above may be explained by variations in the relative importance of the various paths of blood supply to the intestine. That such variations occur in man is illustrated by a recent case report by Shaw concerning a patient who died with infarction of the small bowel after high ligation of the inferior mesenteric artery for carcinoma of the sigmoid colon. Here the superior mesenteric artery played an insignificant part in the blood flow to the ileum. Moreover gradual occlusion of the superior mesenteric artery may allow adequate collateral circulation to develop. We have seen a case of aneurysm of the base of the superior mesenteric artery which was resected without reanastomosis of the vessel and with recovery. Blalock and Levy were able to occlude gradually but completely the celiac axis plus the superior and inferior mesenteric arteries in seven dogs without impairment of their health.

Factors contributing to clot formation at the anastomosis included the very small size of these vessels. They varied between 2.5 and 5.5 mm. in diameter, usually measuring 3 to 4 mm. Shumacker, in a report concerning techniques for anastomosis of small vessels, found the incidence of complications was much greater for arteries of 3.2 mm. or less in diameter than for larger vessels. Since there are some very small vessels in the body which are of critical importance, improvement in techniques for suturing small vessels is desirable. Possibly our incidence of thrombosis might be lowered by using the Z-plasty suggested for small vessel anastomoses by Holman and Hahn.

TABLE 2.—*Findings in Seven Dogs Who were Killed 17 to 98 Days After Anastomosis of Renal to Mesenteric Artery or Celiac Axis*

Dog	Survival, Days	Status of Anastomosis	Comments
855	98	Patent	Renal to inferior mesenteric
995	60	Patent	Renal to celiac axis
856	58	Not examined	Renal to celiac axis; liver and stomach normal at autopsy
922	56	Patent	Renal to celiac axis
72	44	Thrombosed by pale firm clot	Intestines normal
13	45	Patent	.....
971	17	Patent	.....

A second factor contributing to clot formation was disparity in size of the anastomosed vessels, the renal often being smaller than the superior mesenteric. The photograph of the clotted anastomosis from Dog 923 illustrates this problem. It was regularly noted that the clots formed mainly in the dilated vessel just beyond the anastomosis, presumably an area of increased turbulence.

The problem of unequal size was especially marked when the left renal artery was doubled, which was the aggravating situation in our dogs in 2 of 14 instances. The clotted anastomosis from Dog 858, shown in the accompanying photographs, was such a case. The excellent anatomical studies of the renal vessels by Anson have emphasized the com-

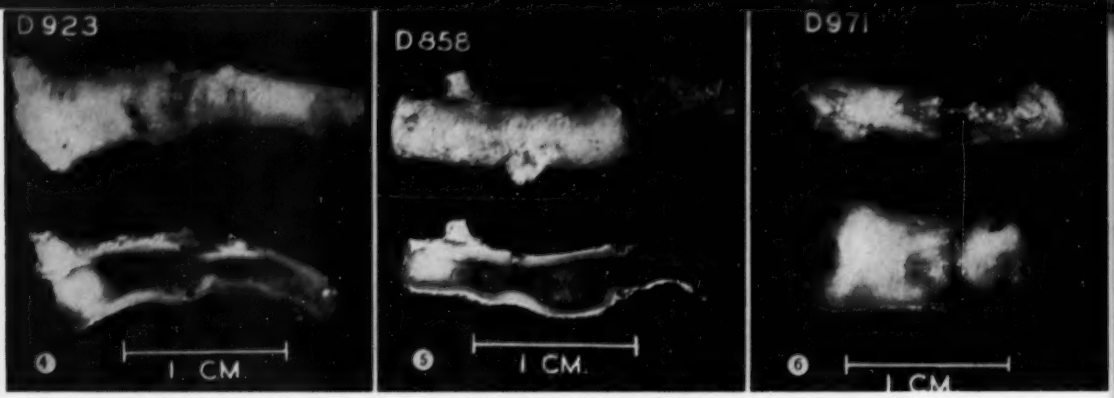

Fig. 4.—Left renal to superior mesenteric artery anastomosis from Dog 923, showing disparity in size of vessels. Above, before opening. Below, opened. Renal artery is on right.

Fig. 5.—Left renal to superior mesenteric artery anastomosis from Dog 858 showing disparity in vessel size. The larger of twin left renal arteries was used. Renal artery on right.

Fig. 6.—Patient anastomosis from Dog 971 killed 17 days after operation. Renal artery on right.

mon occurrence of doubling or tripling of the renal arteries in man, with the multiple vessels possessing approximately equal caliber. It would be very vital, before one embarks on a renal to mesenteric artery anastomosis in the human, to make certain that the left renal artery is single and of sufficient size. Failure to strip the vessels of adventitia carefully and occasional necessity for extra sutures to control bleeding from the suture line also seemed to increase the danger of clotting.

Possibly these results could be improved by use of anticoagulants or antibiotics, neither of which were employed. Nelson and Kremen have shown that either heparin or intestinal tract sterilization by succinylsulfathiazole (Sulfasuxidine) given orally or streptomycin protects the dog against death from temporary occlusion of the superior mesenteric artery. However, in our experiments the mesenteric artery was not occluded for longer than one-half hour, and Nelson and Kremen showed it can be occluded for two hours with regular recovery even if anticoagulants and antibiotics are not used.

An excellent experimental study by Hurwitt on arterial anastomosis appeared in 1953. He showed in dogs that a variety of anastomoses of small arteries within the abdomen can be accomplished successfully. Study at operation and at autopsies has convinced us that left renal to superior mesenteric artery anastomoses are anatomically feasible in man. In the limited series presented here 7 of 14 such anastomoses in dogs were probably successful, one of which is shown in Figure 6. It seems likely that in man, in whom the vessels are larger, the incidence of thrombosis would be smaller, and that the use of anticoagulants and preoperative bowel preparation by antibiotics might reduce the threat of intestinal gangrene if thrombosis did occur. Thus we feel a renal to mesenteric artery union has a fair chance of success, provided the vessels are reasonably similar in size, and could be justified and useful under certain circumstances.

Present problems which might call for this procedure as an adequate solution include traumatic damage to the proximal celiac axis or superior mesenteric artery, either surgical or from penetrating missiles; selected cases of acute obstruction of these vessels by embolism or thrombosis, and localized tumors, such as islet cell carcinoma or a rare adenocarcinoma of the pancreas, located about the base of these arteries. In the latter type of situation, resection of the proximal superior mesenteric artery and of the involved portion of the portal vein, as advocated by Child, would allow an en bloc resection of pancreatic tumors hardly possible when these vessels are left in place.

SUMMARY

In cases requiring resection or ligation of the proximal portion of the superior mesenteric artery or celiac axis, preservation of blood flow may be secured by anastomosis to the left renal artery.

This has been done in 14 dogs with thrombosis at the union in 7. Gangrene of the

viscera thus deprived of arterial blood supply ensued in five.

Anastomosis of the superior mesenteric artery to the lower aorta resulted in thrombosis and ileal infarction in all of six dogs.

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LOCAL TREATMENT OF BURNS CAUSED BY MOLTEN TAR

Experimental Study

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AT A RECENT surgical conference at the Edward J. Meyer Memorial Hospital, the question of how best to treat patients burned by molten tar was raised. Two answers were given to this question: One group maintained that the tar should be removed from the burn site; the other group held that the tar should not be touched, that it would slough off by itself with the underlying damaged tissue without lengthening the healing process or interfering with it.

We used in this experiment a modification of the treatment outlined by Allen and Koch (1943), who suggested sterile petrolatum gauze strips, gauze fluffs, and pressure over the burn site supplied by an elastic roller bandage. This method eliminated dead spaces and prevented the loss of much plasma fluid.

In our procedure we used, in addition to the pressure bandages, thick plaster casts as suggested by Levenson and Lund (1943). However, our purpose was not only to apply pressure but also to prevent the animal from removing his dressings and still permit ambulation. The plaster proved relatively successful but had to be reapplied frequently, since the animals often chewed through the layers of plaster gauze.

Cope (1943) and Levenson and Lund (1943) suggested that burned tissue should not be mechanically disturbed if possible. In their studies they neither débrided the wounds nor cleansed them in any way except to remove the large pieces of foreign material from the burn site. In our study we cleansed the exposed surfaces of the treated right foot with green soap, as described by Elman, Merry, Beguesse, and Tisdale (1946).

Penicillin was used prophylactically in all the animal studies herein outlined (Elman and others, 1946).

METHOD

Five dogs weighing approximately 8 to 10 kg. were subjected to the following procedure:

1. Roofing tar (asphalt) with a melting point of 138 C., supplied by a Buffalo roofing concern,* was heated to 222 C. This temperature was used because it is the temperature at which most roofers apply the material.

2. The animal was anesthetized with veterinary sodium pentobarbital solution either intravenously or intraperitoneally.

3. The dogs' forepaws were shaved to a point several centimeters above the wrist joint.

4. The forepaws were then photographed with a 35-mm. camera using indoor color film.

5. The paws were marked to the desired level with wax pencil and dipped to this mark in the molten tar for a period of two seconds.

6. The tar clinging to the animal's forelimbs was allowed to set for 20 minutes.

7. The tar was removed from the right paw (the control) with ether.

8. The forepaws were then photographed together to show the treated area and the area covered by tar, the left nontreated paw.

9. The right forepaw (control) was then thoroughly cleaned with green soap and dressed with sterile petrolatum gauze. Sterile gauze fluffs were generously applied over the entire burn area and firmly held in place by a 3-in. (7.6 cm.) elastic roller bandage.

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* Universal Roofs and Sidings.

10. The left forepaw was lightly bandaged with a 2-in. (5 cm.) roller gauze applied directly over the tar.

11. Each forepaw was encased in a thick plaster cast consisting of two rolls of 3-in. plaster bandage applied to each limb.

12. The animals were given 1,000,000 units of penicillin procaine intramuscularly daily for at least the first week following the burning procedure. If infection was noted after this period additional penicillin was administered.

13. The casts were removed at irregular intervals of from two days to one week. This procedure was carried out with the animal under sodium pentobarbital anesthesia. The wounds were irrigated with sterile isotonic sodium chloride solution and dressed as previously described, including new plaster casts. Color photographs were taken each time the dressings were changed. This procedure was continued until epithelial regeneration was well advanced. At no time was any attempt made to remove the tar from the untreated forepaw (left).

The two- second burning exposure period was used arbitrarily, assuming that human exposure would probably be no longer than this if a man fell into a hot tar bucket or was splashed with hot tar, a not uncommon occurrence in the trade.

The ether cleaning method proved to be a lengthy task, requiring up to 45 minutes of vigorous treatment for removal of the tar from the few square centimeters of skin involved. The area between the animal's toes was especially difficult to cleanse.

The 222 C. temperature of the tar produced second and third degree (intermediate and full thickness) burns over the entire exposed surface. Edema rapidly developed in the tissue of the cleaned right control forepaw. Edema was noted in the left forepaw on which the tar remained but to a lower degree.

The heavy plaster casts were needed to prevent the animal from removing the dressing and the tar. These casts also enabled the animal to walk without apparent discomfort. The casts were reapplied each week, but often, owing to the dog's persistent efforts to remove the plaster, it was necessary to reapply them more frequently. The dressing and cast treatment was continued until epithelial regeneration was well advanced. At this point the dressings were no longer applied and the wounds were allowed to heal without further treatment.

The tar was allowed to remain on the left foot until it sloughed with the underlying necrotic tissue. When the tar and the underlying tissue had sloughed, the wound was then treated exactly as the right (control) limb had been treated, with sterile petrolatum gauze and pressure dressings. The Table shows the number of days for the tar to slough from the untreated foot, the number of days for marked epithelial regeneration, and the number of days for complete epithelization of the denuded area to take place.

Time Required for Sloughing, Epithelial Regeneration and Complete Epithelization

Dog No.	Tar Sloughed Left Untreated Forepaw, Days	Marked Epithelium Regeneration		Complete Epithelization *	
		Right Treated (Control Forepaw), Days	Left Untreated (Forepaw), Days	Right, Days	Left, Days
1	16	18	18	54	54
2	12	19	19	32	32
3	6	11	11	28	28
4	9	16	16	47	57
5	8	12	14	40	54

* The time required for complete epithelization may actually have been two to three days shorter than recorded, since the animals were not examined each day.

COMMENT

It can be seen from the Table that in all cases but that of Dog 5 marked epithelial regeneration occurred at the same time. In Dog 5, there is a difference of two days in favor of the control or treated burn. Since the observations were made at irregular intervals and were necessarily subjective, the difference in healing progress here may be more apparent than real. Furthermore, a two-day difference at this point does not seem to be significant, when 28 to 57 days are required for complete healing of the wound.

In regard to animals 4 and 5, the treated and untreated wounds were completely healed at different times, with a difference of 10 to 14 days respectively. Since during

the late stage of the experiment no dressings were applied to the burns but the wounds were merely left open to the air and the dogs' own method of "treatment," more attention to one paw than the other by the dog or some slight additional trauma may have accounted for this difference in time required for complete healing of the burned surface.

CONCLUSIONS

The Table shows that, whether or not the tar is removed, burns in dogs caused by molten tar heal at about the same rate. The tar on the untreated limb does not apparently cause any irritation which would slow up the healing process. Actually the thick coating of tar may have prevented the loss of a considerable amount of fluid, as it apparently reduced the edema in the untreated limb.

It is our opinion, however, that the additional trauma inflicted upon a patient whose burns are treated first by removing the tar with ether or other solvents is needless. If the tar is left in place, it saves the patient this damage and the operator the needless tedious task of removing all the tar from the skin surface.

One of us (J. R. N.) accidently experienced a burn of this sort while carrying out the experiment. Considering the time required for removing the tar from the skin and the tenderness of the small area involved, the pain resulting was out of proportion to the final result.

SUMMARY

The forepaws of five dogs were shaved and dipped for two seconds in molten tar at 222 C.

The right paw was cleaned with ether and treated with petrolatum gauze and pressure dressings. The left paw was untreated, except that casts were then applied to protect both burned paws.

Periodic observations were made to determine the healing rate in both paws. Comparative photographs were taken in color.

The initiation of the healing process appeared obvious at the same time, except in one case, in which healing of the untreated limb was about two days slower than that of the treated limb.

Some variation in complete healing was noted but does not seem significant.

It is concluded that either removal or nonremoval of the tar in this type of burn will give the same result; however, since the cleaning procedure inflicts trauma, leaving the tar appears to be the better procedure.

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BEHAVIOR OF SPLIT-THICKNESS, DERMAL, AND FULL-THICKNESS SKIN GRAFTS IN THORACIC CAVITY

An Experimental Study

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THE USE of autogenous dermal skin grafts in clinical thoracic surgery has been reported by several investigators. In 1949, Gebauer * first recorded the use of dermal grafts for the repair of benign strictures of the trachea and bronchus. Sealy,[6] in 1952, wrote of similar experiences with this type of graft in the reconstruction of portions of the trachea. The utilization of a full-thickness skin graft for the repair of a penetrating wound of the trachea was reported in 1953 by Hanner,[7] and split-thickness skin grafts to cover thoracic wall defects have been reported by Pickrell and others.[8]

Experimental data on the growth of skin in the thorax is exceedingly limited. In 1952, Geever [9] recorded the repair of diaphragmatic defects in dogs with cutis grafts. Horton and associates [10] have investigated the use of skin to repair arterial defects of the thoracic and abdominal arteries in dogs. Other than this, no record has been found in the literature of the growth and fate of skin grafts in the thoracic cage.

The behavior characteristics of autogenous skin grafts in positions other than on the external surface of the body is currently receiving limited attention. Skin has been grafted in the mouth,[11] the orbit,[12] the vagina,[13] the urethra,[14] the urinary bladder,[15] on ileostomy stumps,[16] in mastoid cavities,[17] and in hemoplasties [18] and has been used widely as filler substance for contour losses.[19] Recently, Horton and colleagues [20] have described the behavior of skin grafts in the peritoneal cavity of dogs, on omentum, intestines, stomach, liver, spleen, ureter, and aorta. It was found that skin buried in the abdominal cavity grows well and persists, and various conditions were postulated in which the use of such buried grafts might be indicated. The experimental reconstruction of segments of ureters has been accomplished with the use of a tubed skin graft growing on peritoneum.[21] Skin patches of dermis have been used successfully to repair large anterior defects of the thoracic and abdominal aorta in dogs, and circumferential skin grafts show promise in the replacement of total segments of arteries.[10]

With the knowledge of the normal growth characteristics of skin in the thorax, it is hoped that many additional clinical applications may be discovered for procedures employing buried skin grafts.

METHOD OF EXPERIMENT

Healthy adult mongrel dogs were employed as subjects and were anesthetized with sodium pentobarbital given intravenously. An endotracheal tube was inserted for positive pressure oxygenation, and the left side of the chest was shaved and prepared with hexachlorophene (pHisoHex) and benzalkonium (Zephiran). After sterile drapes had been applied, free split-thickness grafts (0.008 in.) were obtained from the chest wall, using the Brown or Padget-Hood dermatome. Dermal grafts of varying size were then cut from the donor split skin areas, and sections of full thickness skin were obtained from nearby normal skin. The grafts were wrapped in saline sponges, while the pleural cavity was entered through a routine intercostal incision. Using interrupted sutures of 00000 black nonabsorbable (surgical) silk, the grafts were securely fixed on the parietal pleura, on chest wall denuded of pleura, on the diaphragm, aorta, esophagus, lungs, trachea,

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* References 1 through 5.

Fig. 1.—Microscopic section of portion of unilocular cyst formed by growth of split skin on intact pleura.

pericardium, and heart. The chest was closed with sutures of 3-0 black silk, and the animals returned to their cages without dressings. All incisions and donor sites healed without complication. Postoperatively, 300,000 units of penicillin was given daily to each dog for seven days.

Grafts in the Thoracic Cavity

Site	Split	Dermal	Full	Total
Lung	4	2	3	9
Diaphragm	2	2	1	5
Pericardium	2	2	1	5
Heart	2	2	1	5
Esophagus	2	2	1	5
Parietal pleura	3	2	1	6
Trachea	1	1	1	3
Aorta	6	5	2	13
Total	22	18	11	51

RESULTS OF EXPERIMENTS

A total of 51 intrathoracic grafts varying in size from 2 to 4 sq. cm. were observed for periods of from one to six months.

Split-Thickness Skin Grafts.—Free autogenous split thickness skin grafts grew without failure in the thorax. When placed on intact parietal or visceral pleura, each

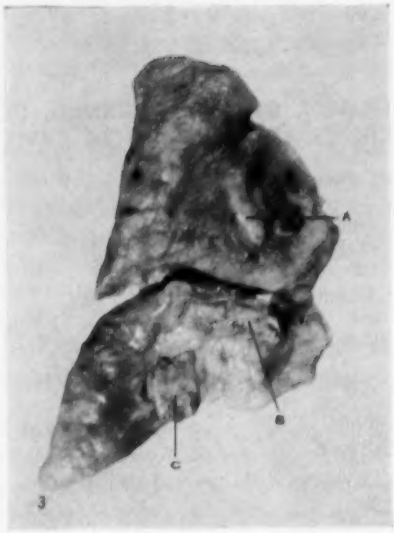
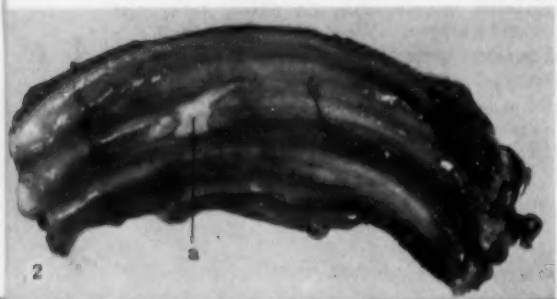


Fig. 3.—*A*, split-thickness skin on upper lobe of lung. *B*, full-thickness skin on lower lobe of lung. *C*, dermal skin graft on lower lobe of lung.

Fig. 4.—The skin grafts shown previously in Figure 3 have been bisected. *A*, the split skin graft has been divided and one-half of the cyst opened to show the unilocular cystic formation. *B*, the full-thickness skin graft has been divided; there is no cyst formation. *C*, the dermal graft has been divided; there is no cyst formation.

Fig. 2.—Split-thickness graft on chest wall denuded of pleura. Note there is no cyst formation.



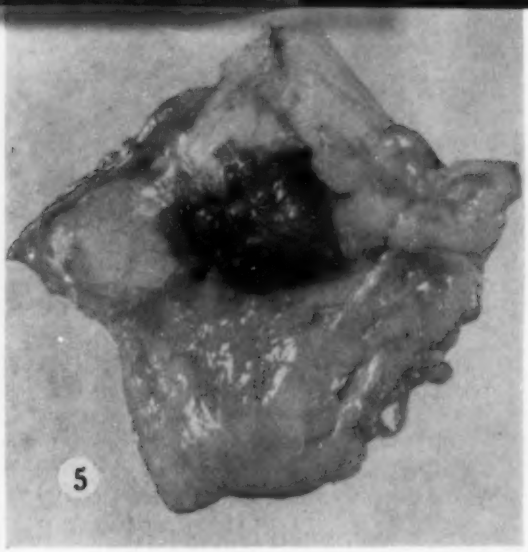
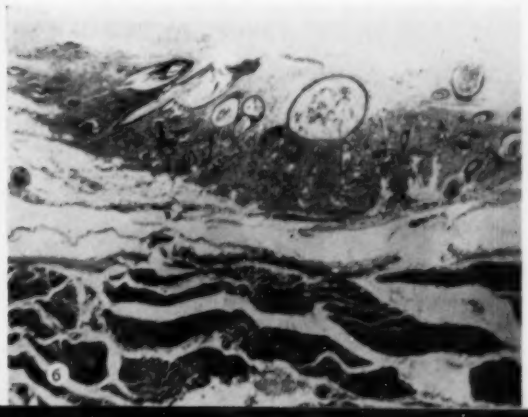


Fig. 5.—Split-thickness skin graft on pericardium. Note the large unilocular cyst formation.

graft formed a large unilocular cyst by the growth of the skin edges superiorly and then medially, in the shape of an incomplete circle, finally to fuse in the central portion (Fig. 1). The interior of the cyst was lined with the graft-stratified squamous epithelium and contained a thick greenish-white material, full of small free stubs of hair and desquamated epithelial cells. With the growth of the graft skin edges superiorly, the normal underlying attached tissue was also pulled partially around the circumference of the graft. The remainder of the tissue, forming a nutrient base from the top of the graft cyst, was composed of vascular fibrous tissue growing over the top of the graft as the skin edges advanced. Split-thickness grafts placed on muscle denuded of pleura did not form a cyst but merged with the nearby cut edges of the pleura (Fig. 2). When several split-skin grafts were placed adjacent one to the other, over intact pleura, the stratified squamous

Fig. 6.—Dermal graft in thorax after one month of growth. Note the intradermal cystic formation.



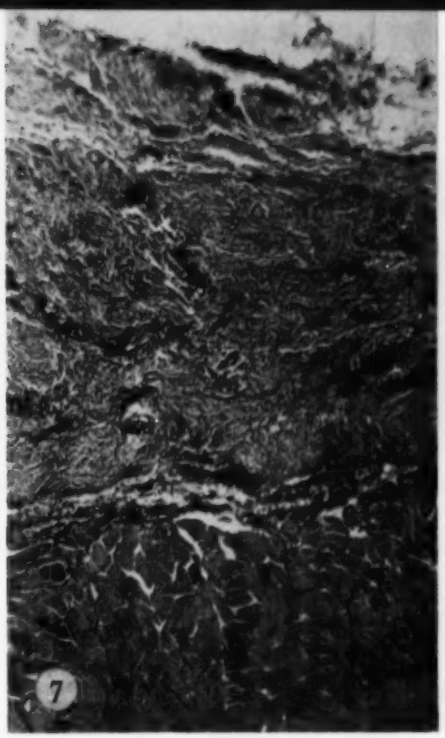


Fig. 7.—Dermal graft in thorax after six months of growth. Note the disappearance of the adnexal glands.

epithelium of the adjacent graft edges merged and only one large cyst was formed.

Split grafts on the lungs formed the expected type of unilocular cyst, but in addition produced immobilization of the lung tissue beneath the graft. In each instance a pneumonic process, as seen in histologic sections, occurred at this site. This did not deter the growth of the graft, and resolution of the

Fig. 8.—Dermal graft on lung.

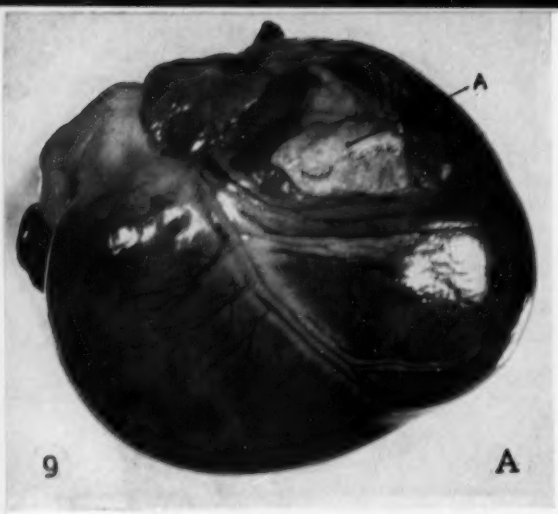
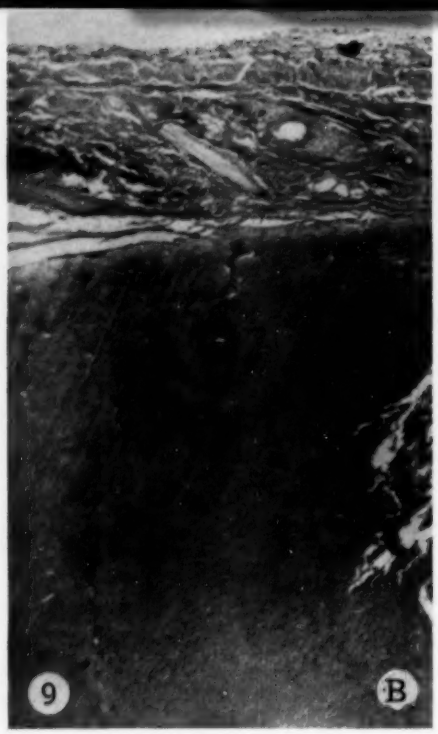


Fig. 9.—*A*, dermal skin graft on heart. *B*, microscopic appearance of dermal graft on heart.



pneumonic process occurred in two to three months (Figs. 3 and 4).

The growth of split skin grafts on the diaphragm did not differ from other pleural covered surfaces or sites. Unilocular cysts formed in each instance; however, in this location, the function of the diaphragm did not seem to be impaired.

Split grafts on the pericardium and heart grew into unilocular cysts lined with stratified squamous epithelium similar to that seen in split skin cysts growing on pleura (Fig. 5). Although the heart was not disturbed grossly by the presence of the cyst, some microscopic distortion of the underlying muscular wall was noted at the site of each graft.

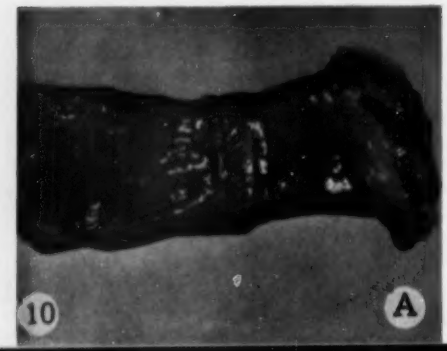
When circumferential split grafts were placed on the esophagus, the grafts again formed unilocular cysts. In addition, the thin split skin contracted markedly during the first three months of growth and produced a partial obstruction of the esophageal lumen.

Split grafts on the trachea likewise formed unilocular cysts and underwent considerable contraction. The exact amount of contraction in each graft is difficult to estimate with accuracy as the skin graft itself is pliable and stretches easily in all directions. Therefore, both the skin graft and the various donor areas change in size and shape according to intrinsic and extrinsic pressures.

Unilocular cystic formation did not occur when circumferential split grafts were placed on the aorta, except in one instance. In the other five cases of split grafts on aorta, the skin united solidly with aorta wall and apparently remained as a living cellular aorta jacket, with no distortion of the vessel.

Dermal Skin Grafts.—When autogenous dermal grafts were placed in the thorax, complete growth occurred in each case. There was no instance of unilocular cyst formation as was noted in buried split skin grafts.

Fig. 10.—*A*, circumferential dermal graft on esophagus. There is no cyst formation and no distortion of the esophagus. *B*, microscopic appearance of dermal graft on esophagus.



After one month of growth in the thorax, the dermis graft was grossly composed of a thick fibrous structure containing numerous small intradermal cystic structures 1 to 2 mm. in size. Microscopically, these small cysts were noted to be the remnants of the adnexal glands, which were showing early signs of disintegration (Fig. 6). After three months of growth, there was noted a marked degree of glandular destruction, and in six months no remnants of epithelium could be found (Fig. 7). The dermal grafts were then uniform gray fibrous tissue of considerable strength and thickness. In no case did large intradermal cystic formation persist, or did the permanent growth of hair occur.

Dermal grafts on the lung grew well, but underneath each graft the lung was involved in a pneumonic process (Fig. 8). Microscopic examination of this immediate area after six months of growth revealed a diffuse fibrosis of the lung, with the graft persisting as a fibrous structure over the periphery. A tendency of the dermal graft on the lung to adhere to the parietal pleura was noted in one animal. In this instance, the adhesions which formed were thick and fibrous in nature.

On the diaphragm, the dermal grafts exhibited no unusual characteristics, persisting as fibrous tissue at about the fifth or sixth month.

Similar grafts on the pericardium grew without difficulty and without large cystic formation. In six months these grafts were also void of epithelial elements and were composed of mature fibrous tissue.

When dermal grafts were placed on the heart, each graft grew without distortion or difficulty (Fig. 9). The constant motion of the heart apparently did not hamper the uniform growth of the graft.

On the esophagus, circumferential dermal grafts grew normally and did not show a detectable degree of contraction. No evidence was seen of obstruction or impairment of peristalsis. No permanent cysts were formed and the graft persisted as a living portion of the esophagus (Fig. 10).

Dermal grafts on the parietal pleura did not form large unilocular cysts, but grew as expected in their original position. Ultimately, no evidence of epithelium was found at the graft site.

Circumferential dermal grafts on the trachea grew uniformly without appreciable contraction or distortion. No large cystic formation was noted, and in five to six months all epithelial elements had disappeared, leaving only a mature fibrous tissue covering.

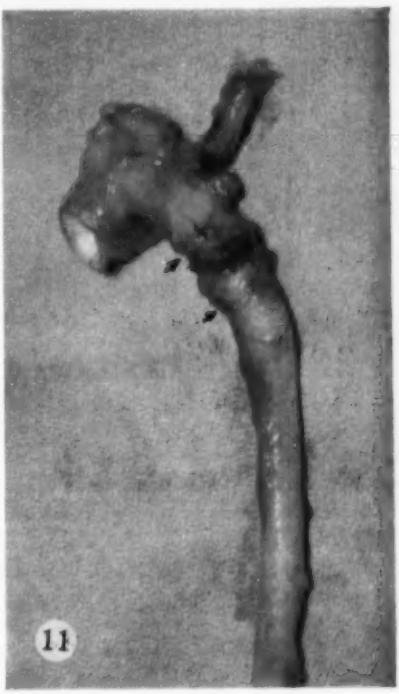


Fig. 11.—Circumferential dermal skin graft on thoracic aorta.

Dermal skin grafts on the thoracic aorta grew without difficulty and added strength and thickness to the vessel wall (Fig. 11). No evidence of distortion was present at any time. Within six months all epithelial elements had disappeared and the aorta was composed of a tough vascular fibrous tissue graft, growing and adhering to the original vessel wall.

Full Thickness Grafts.—The behavior of full-thickness grafts in the thorax did not differ from the growth of dermal grafts in the chest, except that in the first two to three weeks a small growth of hair occurred from the full-thickness skin. Soon after this period, the hairs extruded and were lost. Full thickness skin growing on the lungs, diaphragm, pericardium, heart, esophagus, parietal pleura, trachea, and aorta did not form unilocular cysts, and at about the fifth or sixth month had lost all evidence of epithelium, remaining as highly vascular, adult fibrous tissue. No contraction was evident, and no infection was demonstrated at any time, other than in the lung periphery immediately beneath the graft, as described previously.

COMMENT

The relative value of autogenous split thickness, dermal, and full thickness skin growth in the thoracic cavity is easily determined by this experiment. Since split thickness skin grafts form unilocular cysts on intact pleural surfaces, whereas dermal and full thickness grafts do not, a definite superiority of the latter types of buried grafts is demonstrated. It is also apparent that the dermal graft has all of the virtues of the full-thickness graft, and in addition, possesses certain extra qualities of desirability. The dermal graft does not temporarily grow hair as does the full-thickness graft. Potentially, the dermal graft is a cleaner graft, with less likelihood of infection from skin bacteria. The problem of repair of the donor site in clinical surgery is negligible when dermal grafts are utilized, since the split-thickness graft previously removed from the dermis may be replaced to cover the full-thickness skin loss. When full-thickness skin alone is used, additional methods of wound closure would be necessary. Therefore, with the exception of split skin grafts used as linings for denuded thoracic wall flaps, the buried dermal graft is apparently the graft of choice in the thorax.

We believe the investigation of such buried grafts should be continued, as there are many potential uses for free living grafts in the chest. Further study of skin on the esophagus is now underway in our laboratory. We hope to report the reconstruction of total segments of the esophagus with skin in the near future. In addition, if an anastomosis between severed esophageal ends is under tension, the use of a broad circumferential dermal graft over the suture line may prove desirable, to relieve the tension and prevent leakage.

Dermal skin grafts of the trachea have previously been utilized with success in certain selected cases of stenosis of the trachea and bronchi. In addition, dermal grafts could be used to assure an airtight anastomosis between a severed bronchus or trachea by reinforcing the suture line with a graft. The reconstruction of a circumferential segment of trachea or bronchus presents many technical problems at present, but these may be overcome after thorough investigation.

Dermis may be used as a reinforcing material for thoracic aneurysms. De Takats [22] and Lowenberg [23] have successfully used cutis grafts as a supporting jacket around abdominal aorta aneurysms. Although this procedure has not been attempted in the thorax, the data presented in this experiment indicates that it is possible to extend the operation to include, in certain instances, aneurysms of the thoracic aorta.

Cooley and De Bakey [24] cast considerable doubt on the value of nonautogenous irritating substances placed on the outside of aneurysms to promote fibroplasia. It is felt that placing an impervious, nonvascular material on the exterior of the vessel wall may preclude all chance of extrinsic nourishment to the aneurysm. If, in addition, the aorta wall is malnourished from the interior, owing to thrombi and disease, the tendency to rupture may be enhanced, instead of retarded. On the other hand, such a tendency would not be present with dermal graft reinforcement of diseased vessels, since the graft is a vascularized, growing, living support. When portions of aneurysms are excised and the remaining vessel wall tailored to produce a normal-sized vascular channel,[25] it is logical to assume that such a dermal graft sleeve

would greatly aid in supporting the remaining vessel wall.

Other uses for the buried skin graft may become apparent after more thorough study and investigation. We hope to have additional data on the clinical indications and application of buried autogenous skin grafts in the thorax in the near future.

SUMMARY AND CONCLUSIONS

1. Although buried autogenous skin grafts have been utilized in clinical thoracic surgery, few data on the experimental behavior and the fate of skin grafts inside the chest have been found.

2. Autogenous split-thickness, dermal, and full-thickness grafts grow without failure, when fixed securely on the lung, diaphragm, pericardium, heart, esophagus, parietal pleura, trachea, and thoracic aorta.

3. Split-thickness skin grafts grow to form a large unilocular cyst, when placed on intact pleura, pericardium, or heart.

4. Adjacent grafts of split-thickness skin on intact pleura unite to form one large skin graft, which produces a unilocular cyst by peripheral skin growth.

5. Intrathoracic split-thickness skin on areas denuded of parietal pleura does not encyst, but merges with the adjacent edge of normal pleura.

6. Split-thickness skin grafts undergo inherent contraction when placed on uninjured areas inside the thoracic cavity.

7. Dermal grafts do not form large unilocular cysts, but remain flat and free of distortion when growing on the lung, diaphragm, pericardium, heart, esophagus, parietal pleura, trachea and aorta.

8. Circumferential dermal grafts show no appreciable evidence of contraction or disturbance when placed around tubular structures such as the esophagus, trachea, and aorta.

9. Small, 1 to 2 mm., intradermal cysts occur in buried dermal grafts within the first month of graft growth. These cysts disappear and all epithelial structures of the graft disintegrate within six months, leaving a firm fibrous tissue which represents the original graft.

10. Full-thickness grafts do not form large unilocular cysts as does split thickness skin.

11. Minute intradermal cysts, 1 to 2 mm. in diameter, occur in the full thickness graft, as in the dermal graft, and disappear with the adnexal glands over a six months' period, leaving a fibrous tissue form representing the original skin.

12. A few small hairs show temporary growth in buried full-thickness skin grafts, but these hairs are extruded within four to six weeks postoperatively.

13. Dermal grafts are apparently superior to full-thickness and split-thickness grafts in the majority of intrathoracic grafting procedures.

Possible clinical applications of these findings are discussed.

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PANNICULAR LUMBOSACROILIAC HERNIA

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PAINFUL pathologic conditions of the back are the source of much medical and surgical interest. So intense is the interest in this subject that symposia are held almost annually at meetings in order to unravel the conundrum of "backache." These symposia feature panel discussions composed of a neurosurgeon, radiologist, orthopedist, and physiatrist. Often these meetings terminate without answering all the questions concerning pain in the back.

It is fitting, therefore, that when there is a cure for one cause of backache that this entity should be emphasized. Specific reference is made to an infrequently discussed cause for low back pain, namely, subfascial fat herniation. The presence of this condition was first described by the English authors Copeman and Ackerman, in 1944. A year later Ralph Herz, of Key West, Florida, corroborated their findings. Since 1945, he has written and lectured extensively on subfascial fat herniation as a cause of low back pain.*

Since 1945 there have been sporadic references in the literature to herniation of fascial fat.† Including those of the original authors, there are no more than six articles on this subject.

Unfortunately, there has been no uniformity of terminology to describe this clinicopathologic entity, and for this reason some articles may be hidden in the literature under an unfamiliar name. It is proposed, therefore, that herniation of fascial fat as a cause of low back pain be called pannicular lumbosacroiliac hernia. The adjective pannicular is used to emphasize the "fatty" nature of the hernia, and lumbosacroiliac, to denote the commonest hernial sites in the low back area.

ETIOLOGY AND PATHOLOGY

Beneath the deep fascial layer of the back is a stratum of fat (Fig. 1). This is a normal anatomic layer which has not been stressed sufficiently by surgical anatomists. When this subfascial fat comes through, or pierces, the deep fascia which confines it, a hernia

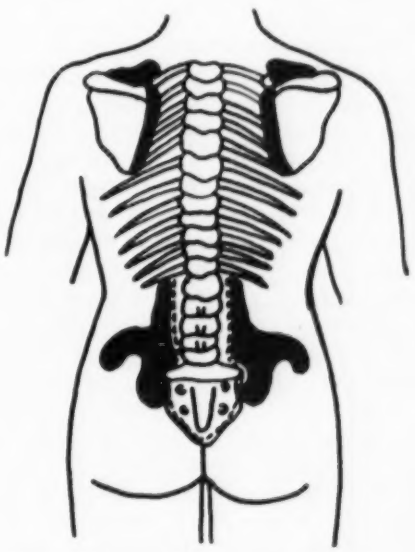

Fig. 1.—Diagrammatic presentation of the normal distribution of subfascial fat according to Copeman and Ackerman. (This illustration is reproduced through the courtesy of Dr. Ralph Herz.)

results. It usually occurs in the lumbosacral or sacroiliac region, as a result of trauma which produces a weakened area or rent in this deep fascial layer.

Another etiologic factor is the sudden loss of weight in obese women. This loosens the subfascial fat, and in the areas where the cutaneous branches of the posterior rami of the last three lumbar nerves pierce the deep

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* References 1-4.

† References 5 and 6.

fascia (through definite foramina or interstices) a globule of loosened fat may protrude through these openings, resulting in a pannicular hernia. Although these herniations are usually unilateral, they may be bilateral.

Pathologically, pannicular hernia is ordinary fat tissue which has passed from its normal anatomic location in the subfascial space to a more superficial stratum. This fatty tissue may assume different shapes and may be solitary or clustered like a "bunch of grapes." Copeman and Ackerman have classified the fat tissue as pedunculated, nonpedunculated, and foraminal. Histologic section demonstrates normal fat tissue.

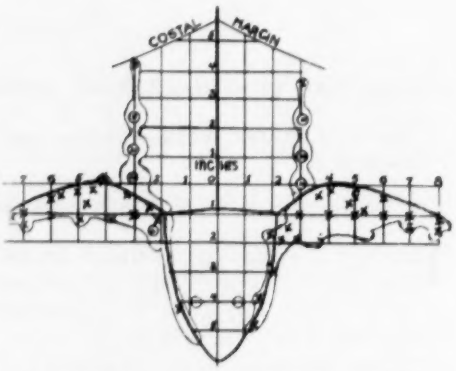

Fig. 2.—Distribution of trigger points of pain and the sites of pain patterns as reported by Copeman and Ackerman. (Illustration reproduced through the kindness of Dr. Ralph Herz.)

CLINICAL PICTURE

The patient with a pannicular hernia seeks medical care for one of two reasons—pain or the presence of a mass in the lumbar or sacroiliac regions. Pain is most prominent when the fat tissue pushes through the foramina of the lumbar nerves, as previously mentioned. The pain is severe, and the patient may be unable to move at the height of the pain. Almost all patients will complain of some degree of backache, which the patient can localize to a trigger area (Fig. 2). The pain in the back may be referred to the sciatic region, the thigh, testis, or elsewhere.

When the patient feels the mass or masses they are painful nodules. The chief finding is single or multiple painful nodules. Palpation of the lumbodorsal area will elicit trigger points of pain (Fig. 2). Copeman and Ackerman found that the distribution of fat in the lumbar and lumbosacral area in an anatomical study of cadavers coincided with the distribution of trigger points of pain, which they call "pain pattern."

This pain follows a pattern which commences above and goes downward along the lateral border of the sacrospinalis muscle from the costal margin to the crest of the ilium. In the gluteal region the points are found along the crest of the ilium, a little below the crest, and at the level of the posterior iliac spine. These trigger points are similarly found along the sacroiliac joint level. The Table presents the salient features of six patients who had pannicular hernias which were treated surgically.

In addition to the six cases presented, many other patients were seen who had pannicular lumbosacroiliac hernias. Most of these refused surgery and were treated by local infiltrating anesthesia of 1% procaine

Case Studies

Case No.	Age, Yr.	Sex	Occupation	Major Complaint	Duration of Symptoms	Result Following Surgery
1	29	F	Housewife	Acute low back pain bilaterally	7 mo.	Excellent
2	41	F	Secretary	Fell downstairs, causing pain in left iliac crest	1 yr.	Excellent
3	40	M	Painter	Fell from scaffold, pain right iliac crest	3 mo.	Excellent
4	35	F	Housewife	Left-sided backache after pushing chair	2 mo.	Excellent
5	40	M	Bank guard	Painted his floors on holiday; low backache	2 wk.	Excellent
6	50	M	Physician	Lumbar pain after shoveling snow	3 wk.	Excellent

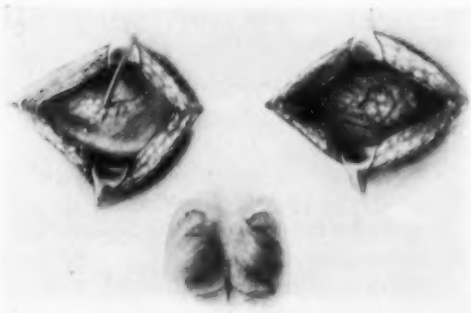

Fig. 3.—Operative incisions employed for the identification and repair of pannicular hernias. (Courtesy of Dr. Ralph Herz.)

hydrochloride (Novocaine). The six cases are reported because they actually came to surgery and the true nature of the pathology was established at the operating table. It is remarkable to note that these patients are permanently relieved of pain when surgery is accomplished.

DIFFERENTIAL DIAGNOSIS

Palpation of a painful nodule or nodules in the lower back should lead one to suspect the presence of a pannicular hernia. Fibrositis or myofascitis are terms frequently given to subfascial fat herniation, since it has been erroneously thought that nodules in the back are due to excessive fibrous tissue.

When these pannicular hernias are found, a therapeutic test via an injection of 1% procaine hydrochloride beneath the nodule will give almost immediate relief, and this is a valuable diagnostic aid.

In the differential diagnosis a careful history is important. A history of injury, a fall, or rapid loss of weight is significant. An adequate physical examination demonstrates painful nodules and trigger points either unilaterally or bilaterally.

Routine x-ray studies of the spine should be taken to eliminate disease or injury to the bone, because one or more causes of "pain in the back" may exist simultaneously.

When fatty tissue is found at the time of the operation, one other entity must be considered. This entity is panniculitis, which is an inflammation of subcutaneous fatty tissue. Panniculitis may be associated with other rheumatic manifestations or Weber-Christian disease (relapsing nodular panniculitis). This disease is a clinicopathologic complex characterized by recurrent febrile episodes and the presence of multiple small tender nonsuppurative subcutaneous nodules. The pathologic changes involve the subcutaneous fat in a nonspecific inflammatory reaction, which may result in fat necrosis and fibrosis. The characteristic pathologic picture of Weber-Christian disease is manifested in the subcutaneous and visceral fat. Other organs, such as the liver, heart, and spleen may show nonspecific changes.

TREATMENT

The treatment of pannicular lumbosacroiliac herniation is either nonoperative or operative. The former mode of therapy consists in the local injection of 1% procaine hydrochloride or similar solution beneath the nodules. This therapy usually results in a dramatic relief of pain. The injection may be repeated as often as necessary for symptomatic relief. The disadvantages of this mode of treatment are that (1) it is symptomatic therapy; (2) the diagnosis is not established; (3) the underlying pathology is not corrected; (4) an acute disease which could be corrected surgically may result in a chronic disease necessitating prolonged symptomatic therapy.

Surgical treatment is definitive and permanent. Local anesthesia is preferred when the masses are not definitely palpable. This form of anesthesia allows the patient to assist the surgeon in the proper localization of the lesion. Skin infiltration is accomplished with

Fig. 4.—Postoperative incisions as seen in patient reported as Case 1. Arrow indicates the level of the iliac crest.

procaine hydrochloride in a transverse line over the nodule or nodules. An incision is made over the anesthetized area (Fig. 3). The incision is carried down through the superficial fascia, and the mass of lobulated fat presents itself into the operative site. Usually the mass is much larger than anticipated. The mass is removed via sharp and blunt dissection. On occasion it is difficult to delineate the exact extent of the fatty masses. When this situation exists, it is often necessary to remove adjacent fat tissue in order to adequately excise the pannicular hernia. When this herniated fat is removed, an aponeurotic dehiscence or a foramen through which the fat has emanated can be seen. It is necessary to obliterate this orifice in order to prevent a recurrence. Absorbable (catgut) surgical sutures has been my preference to close this orifice. All bleeding should be controlled, as hematomas form easily in this locality. A rubber tissue drain is employed for 48 hours to allow drainage of serosanguinous fluid that usually accumulates.

It should be remembered that incisions in the lumbodorsal area do not heal as rapidly or as neatly as those on the anterior abdominal wall. Sutures therefore are rarely removed before the 10th or 12th postoperative day (Fig. 4).

SUMMARY AND CONCLUSIONS

Attention is called to a curable cause of low back pain.

This entity is the herniation of subfascial fat through the fascia that confines it.

A name for this type of hernia is pannicular lumbosacroiliac hernia.

Definitive surgical removal of the herniated fat usually results in a permanent cure.

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EFFECT OF INTRAVENOUS CALCIUM GLUCONATE ON POST-TRANSFUSION HYPOTENSION

Clinical Observations

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ONE OF the problems occasionally encountered in the management of seriously injured casualties is post-transfusion, postoperative hypotension. The syndrome occurs within the first 24 hours after transfusion and operation, developing in the seriously injured casualty who has been resuscitated with difficulty. Characteristically, the hypotension will respond to additional transfusions, although, clinically, the transfusion requirements, being large, may seem out of proportion to blood loss. Less frequently the hypotension will be progressive and refractory to subsequent transfusions and only temporarily responsive to vasoconstrictors. Autopsy of such patients usually revealed an increased weight of the lung.[1] This finding suggested the probability of pulmonary edema secondary to cardiac insufficiency.

Post-transfusion hypotension, noted in approximately 10% of a series of 70 dogs after the treatment of hemorrhagic shock with citrated blood, was found to respond to the intravenous injection of calcium lactate.*

Meroney and Herndon,[2] working in the Renal Insufficiency Center in Korea, demonstrated the striking improvement in cardiac function when the hyperkalemic patient was treated intravenously with calcium solutions. A transient state of hyperkalemia was noted, 12 to 24 hours after injury, in some of the more severely injured casualties who had not developed renal insufficiency.[3]

Scott and his associates [4] demonstrated the marked alterations in hepatic function of the battle casualty following massive injuries. Citrate metabolism was not included in their hepatic studies.

This study, therefore, had as its purpose, the empirical evaluation of intravenous calcium gluconate in the treatment of post-transfusion hypotension. It has been based on the hypothesis that a relative insufficiency in hepatic function following severe injury may result in a slowing of the metabolism of citrate which, as an anticoagulant, is administered in large quantities during the course of massive transfusions. This might be associated with a reduction in the concentration of ionized calcium in the serum. A reduction in the ratio of ionized calcium to potassium concentration in the serum would be even more likely since the serum potassium not infrequently rose during the postoperative period. A reduction in cardiac output might, therefore, result. Since the concentration of ionized calcium in the serum cannot be measured chemically, a therapeutic test of calcium appeared the most direct method of approach.

Four normotensive controls, three battle casualties, and one patient with obstructive jaundice have been included in this report. Except for the last patient, all were young men, previously healthy, in the 20- to 30-year age range.

RESULTS

Of the four control subjects, two were normal men and two had received minor injuries. Each was observed for one hour after the intravenous injection of 10 cc. of 10% calcium gluconate. One patient noted an increased sense of warmth, but there was no detectable cardiovascular response. The blood pressure and pulse rate were not altered.

From the Surgical Research Team in Korea of the Army Medical Service Graduate School, United States Army.

* Strawitz, J. G.: Unpublished data.

Four patients demonstrated a striking response to calcium.

CASE 1.—This 21-year-old soldier suffered shell fragment wounds which resulted in a compound, comminuted fracture of the mandible and left humerus, a perforating wound of the left shoulder, and shell fragment wounds of the left leg and right arm. He arrived at the forward hospital in moderate shock. Resuscitation was difficult because of a persistently bleeding lingual artery. Four thousand five hundred cubic centimeters of blood was given preoperatively and 5,000 cc. during operation. The left lingual artery was ligated, and multiple wounds were débrided. Postoperatively the systolic blood pressure remained at 80 mm. Hg, and the pulse rate 120 per minute despite an additional 2,500 cc. of blood. Five hours postoperatively 1 gm. of calcium gluconate in 10 cc. of distilled water was given intravenously over a period of two to three minutes. There was an immediate rise in blood pressure to 120/80 (Fig. 1); pulse rate, 120 per minute. The pulse volume and heart tones were clinically improved. There was an increase in respiratory rate and excursion. The blood pressure was maintained at normal levels as 500 cc. of dextran and 1,000 cc. of 5% dextrose in water were given over a period of several hours. His subsequent course was uncomplicated.

CASE 2.—This Korean soldier suffered shell fragment wounds of the head, left thigh, right knee, and right forearm. At operation a bony defect in the right frontoparietal region was explored, and wounds of the arms and legs were débrided. The patient received 2,000 cc. of whole blood preoperatively and 2,000 cc. in the operating room. Postoperatively, his blood pressure remained at levels between 80 and 85 mm. systolic for three hours. Further transfusion could not be justified on the basis of a minimal blood loss. One gram of calcium gluconate in 10 cc. of distilled water was given intravenously. The blood pressure immediately rose to 104/70 and was maintained at this level without further transfusion. Clinical improvement of the pulse volume was noted. There was an increase in respiratory rate and excursion. His subsequent course suggested that his normal pressure was approximately 105 mm. systolic, a pressure often noted among the Korean soldiers.

CASE 3.—This 23-year-old American soldier was wounded by mortar shell fragments, suffering penetrating wounds of the right arm, right lower thorax, right thigh, lower and middle-back. He was admitted to the Surgical Hospital in severe shock and requiring 3,500 cc. of blood and 1,000 cc. of dextran for immediate resuscitation. At surgery a lacerating wound of the right lower lobe of the lung, a large laceration of the right lobe of the liver, and penetrating wounds of the stomach and proximal ileum were found. Bleeding was controlled and repair of the bowel was performed. Because of the patient's critical condition, the soft tissue wounds of the extremities were not débrided. He was returned to the ward having received a total of 7,000 cc. of blood and 1,000 cc. of dextran. His blood pressure and pulse were unobtainable at this time. An additional 2,000 cc. of blood was given, without clinical improvement.

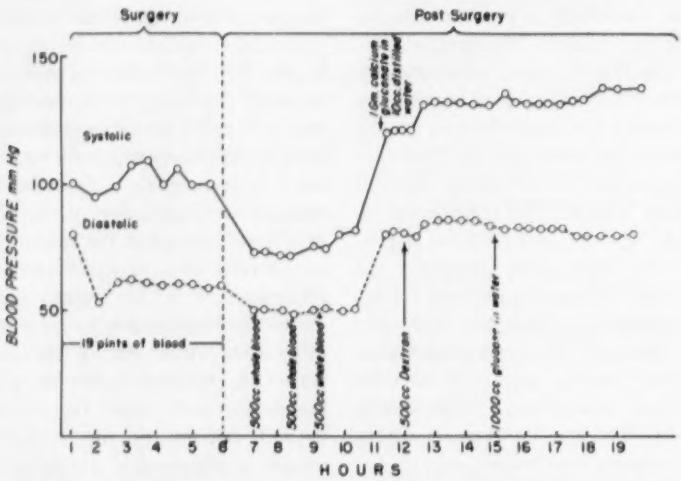

Fig. 1. (Patient 1).—Postoperative, post-transfusion hypotension: Demonstrating the striking elevation in blood pressure following the injection of calcium gluconate. This casualty had received 12,000 cc. of citrated blood.

Two grams of calcium gluconate was then given intravenously over a period of three to four minutes. There was an immediate rise in his blood pressure from an imperceptible level to 85 mm. systolic. The radial pulse became palpable, and the heart tones were louder. Another gram of calcium gluconate produced an elevation to 100/50. This was maintained for 1.5 hours, whereupon a sudden drop in pressure and an increase in pulse rate occurred. Alternate blood and dextran infusions were instituted, and the blood pressure and pulse were maintained for 16 hours until the patient died.

Autopsy revealed a retroperitoneal hematoma, large intraperitoneal blood clots, severe laceration of the right lobe of the liver, surgical absence of the right kidney, and marked pulmonary edema. Death may have been due to overtransfusion.

whose response was most striking. Several others demonstrated a transient response to the injection of calcium. A greater number demonstrated no response at all.

Although the effect of calcium was transient in several of these patients, and several of them died as a result of their wounds, its beneficial effect was occasionally very striking. Its effect on the blood pressure was detectable within one or two minutes after injection. The last patient was included because the pre-existing hepatic damage and the response to calcium injection were both quite marked.

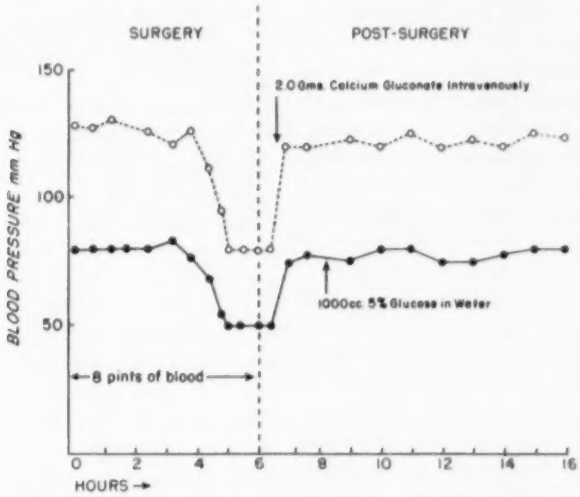

Fig. 2.—Postoperative, post-transfusion hypotension: Demonstrating again the response in blood pressure following the injection of calcium gluconate. This patient, with obstructive jaundice, had received only 4,000 cc. of blood but had preexisting hepatic damage.

Case 4.—This 60-year-old patient had obstructive jaundice secondary to a carcinoma of the head of the pancreas. Pancreatectomy was associated with moderate blood loss which did not appear to approach the 4,000 cc. of blood which he received. Nevertheless, his systolic blood pressure remained 80 to 85 mm/Hg for the last 45 minutes of the operation. After the rapid intravenous injection of 2 gm. of calcium gluconate, his systolic pressure immediately rose to 115 mm., a level which was subsequently maintained (Fig. 2).

COMMENT

These four patients were selected from a larger group as representing the patients

Beyond the fact that several patients demonstrated a striking response, a fact which justifies further study, the results cannot yet be interpreted. The dose of calcium to be injected was selected arbitrarily. One gram of calcium gluconate contains approximately 90 mg. of calcium. If this is all made available to the body as ionized calcium, it is equivalent to approximately 60% of the total ionized calcium in the serum. A distinct, though transient, rise in the ionized calcium concentration of the serum would, therefore, be expected. Since the casualty may have

received the equivalent of a complete exchange transfusion of citrated, calcium-bound blood, such a dose of calcium might well assist in the body's effort in rapidly returning calcium to the ionized state. The presence of an actual deficit in the ionized calcium concentration has not been demonstrated; it may only be that a relative deficit is present. Ionic calcium is a vital cation, contributing with sodium, potassium, and magnesium to the function of muscle and nerve cells. Their role in maintaining adequate cardiovascular function is unquestioned. Further study of the cations as well as the phosphate and citrate content of serum may explain the mechanism of the cardiovascular response to calcium. Certainly the role of transfusion and citrate in this response has not been proved to date. Respiratory stimulation, although noted as a response to the injection, was transient. By increasing the return of blood to the right heart, it could have been a contributing but minor factor in the response.

SUMMARY

After massive injury and massive transfusion, secondary hypotension occasionally developed in the battle casualty. Hypotension, under these circumstances, would sometimes respond to the intravenous injection of calcium gluconate. Continued study is necessary, but the clinical impression has been that the injection of calcium improved the cardiac function, as indicated by increased quality of the heart sounds, pulse volume, and blood pressure.

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CHOLANGIOGRAPHY

A Critical Analysis

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CHOLANGIOGRAPHY is the roentgenologic or roentgenoscopic examination of the biliary tract with the aid of a radiopaque medium instilled into the bile ducts, usually through a tube or needle. The history of the development of the procedure from the first instillation of barium paste in a biliary fistula, in 1918, to the more modern postoperative cholangiogram as first used by Saralegui, in 1926, and the operative cholangiogram as described by Mirizzi, in 1931, has been discussed rather extensively elsewhere * and will not be reviewed further.

The value of cholangiography in providing the surgeon with detailed anatomic and pathologic information has been attested to frequently.† It also has been agreed by many authors ‡ that this procedure will lower the incidence of unnecessary common duct explorations, especially in patients who are poor surgical risks, and thus increase the safety of biliary tract surgery. Secondary operations can be avoided by use of the cholangiogram to demonstrate overlooked stones in the common duct while the patient is still on the operating table and before the abdominal incision is closed.

Despite its many advantages, this procedure has not had as wide an acceptance as we feel it deserves. There are several reasons for this. 1. It is a relatively new procedure. 2. There are many technical inconveniences associated with the procedure. 3. There is a lack of interest in this problem on the part of the roentgenologist and the surgeon. Perhaps indicative of the last item is the complete lack of papers on cholangiography in the more popular American roentgenological journals during the past five years. What some of these difficulties are and how many of them can be overcome will be discussed later in this presentation.

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* References 6, 10, 15, 16, and 19.

† References 8 and 15.

‡ References 5, 7, 9, 13, 15, and 17.

MATERIAL

The present study consists of 158 cases admitted to the Pavilion Surgical Services of The New York Hospital during the five-year period from 1947 to 1952. These patients had one or more cholangiograms performed in relation to a choledochotomy or other pertinent surgical procedure while under the care of that department. The indications for common duct exploration at this hospital have been stated previously by Glenn [6] and include the following: (1) palpable stone within the common duct; (2) a history of jaundice preceded by or associated with pain or intermittent elevation of temperature; (3) a thickened common duct wall, with or without dilatation; (4) contracted gall bladder containing stones; (5) dilated cystic duct; (6) enlarged head of the pancreas, and (7) a prolonged history of biliary tract disease in a patient more than 60 years old.

There are 171 operative cholangiograms and 234 postoperative cholangiograms included in this study. No indications for cholangiography were ever formulated, the advisability of performing it being left to the discretion of the surgeon. Similarly, no set standard procedure was used during this period, so that the operative cholangiograms include precholedochotomy and postcholedochotomy cholangiograms done by instillation

TABLE 1.—*Operative and Clinical Diagnosis*

	Cases
Cholelithiasis and choledocholithiasis	72
Choledocholithiasis (previous cholecystectomy)	19
Cholelithiasis and choledochotomy (no stones found)	33
Chronic cholecystitis and choledochotomy (no stones found)	4
Choledochotomy only (previous cholecystectomy —no duct stones)	5
Stone of cystic duct stump only	3
Stone of cystic duct stump and common bile duct	1
Stricture common bile duct	6
Stricture common hepatic duct	2
Stricture common hepatic duct with stone	1
Obstruction distal common bile duct by extrinsic pressure	1
Obstruction distal common bile duct by extrinsic pressure, with stones	1
Choledochoduodenal fistula	1
Choledochal cyst only	1
Papilloma left hepatic duct with stone and cyst	1
Carcinoma common bile duct	2
Carcinoma common hepatic duct	3
Carcinoma common bile and hepatic ducts	1
Carcinoma ampulla of Vator	1
Total cases	158

of iodized oil U. S. P. (Lipiodol) or iodopyracet (Diodrast) via needle, catheter, or T-tube inserted into the cystic, common hepatic, or common bile duct. Likewise, while most of the postoperative cholangiograms were done with fluoroscopic control, this was not universally true; also, both opaque media were used, and the judgment of the fluoroscopist was the supreme guide, with no standard films obtained. This situation made evaluation of the cases used in this review somewhat more difficult.

Of the 158 cases, biliary duct stones were found in 95, in 4 of which there were other associated findings, as outlined in Table 1. Nineteen of the 91 cases of choledocholithiasis alone had had previous cholecystectomy at varying earlier intervals. No biliary duct abnormality was evident in 42 cases, 5 of which had had previous cholecystectomy and in which a choledochotomy was performed. Four of these cases had chronic cholecystitis without gallstones, and the remaining 33 cholelithiasis. There were four cases of calculus of a cystic duct stump. Nine cases of stricture of the common hepatic duct or common bile duct following previous biliary tract surgery are included, as well as two cases of obstruction of the distal common duct, believed by the operating surgeon to be due to extrinsic pressure.

There were eight cases of tumor of the biliary tract, or 5.06% of the entire series. Of these, seven, or 4.43%, were malignant tumors (carcinoma). This does not represent all biliary tract tumors seen at this hospital during this period. Only those cases in which cholangiograms were performed are included in this series.

Since routine cholangiograms were not done before common duct exploration, all the aforementioned pathology was not demonstrated roentgenographically. The pathology present was demonstrated in 55 cases (or 34.81% of all cases) and in 96 cholangiograms (or 23.76% of all cholangiograms), as outlined in Table 2. These figures substantiate our impression that cholangiography has been used by the surgeons at this hospital predominantly under the following conditions: (1) when anatomic abnormality is suspected; (2) when stones or other pathology may be present, and (3) postoperatively, as a final check of the patient's status before removal of the drainage tube.

Ideally, abnormalities should have been demonstrated by cholangiography in the 116 cases in which pathology of the biliary ducts was present. Because cholangiography was not done before choledochotomy, the actual figure is only 55 cases, or 47.41% of the cases with pathology (Table 2). Forty cases (74 cholangiograms) showed biliary duct stones, of which 15 cases (21 cholangiograms) showed complete obstruction (Ta-

TABLE 2.—*Pathology Demonstrated by Cholangiograms*

Operative cholangiograms (all types)		171
Postoperative cholangiograms		234
Total	158 cases	405 cholangiograms

Demonstrated Pathology	Cases	Cholangiograms
Duct stones	40	74
Tumors	8	11
Stricture	6	7
Choledochal cyst	1	4
Total cases pathology	55	96
	34.81%	23.76%

TABLE 3.—*Demonstrated Obstruction of Bile Ducts*

Cause of Obstruction	Cases	Cholangiograms
Stones	15	21
Tumor	5	7
Stricture	6	7
Total	26	35

ble 3). All six cases of demonstrated stricture (seven cholangiograms) showed obstruction. Only five of the eight cases of tumor of the biliary tract showed complete obstruction (Table 3).

THE NORMAL CHOLANGIOGRAM

The normal anatomy of the biliary tract has been fully covered by many other authors, notably Golden,[6] Norman,[14] Partington and Sachs,[15] Poppel and co-workers,[16] Sachs,[18] and Sterling and his associates.[20] We should like, however, to emphasize a few points which do not seem to be readily appreciated.

The first point of interest is the presence of two right hepatic ducts, named and well demonstrated by Norman[14] as the ventrocranial and the dorsocaudal branches, the latter often taking an anomalous course sharply downward and to the right (Fig. 1*C* and *D*).

We have found many roentgenologists and surgeons to be confused by the narrowing of the distal portion of the common bile duct as it obliquely traverses the medial wall of the descending duodenum (Figs. 1*C* and *D* and 2*A*). This transduodenal segment has been shown by Partington and Sachs[15] and Poppel and his colleagues[16] to measure 1 to 2 mm. in diameter and 10 to 15 mm. in length. We have measured this region in 89 instances in which it was adequately demonstrated and regardless of other findings; the width ranged from 1 to 9 mm., with an average of 2.23 mm., and the length ranged from 8 to 20 mm., with an average of 13.01 mm. (Table 5).

TABLE 4.—*Localization of Papilla of Vater*

	Cases
Upper third of descending duodenum	0
Middle third of descending duodenum	41
Junction middle and lower thirds of descending duodenum	7
Lower third of descending duodenum	60
Junction descending and transverse duodenum	3
Transverse duodenum	1
Total	112
Not localizable	46
Total cases	158

The location of the papilla of Vater, as determined by the relationship of the entering common bile duct to the duodenal swing (Fig. 2*B*), was discernible in 112 cases. Such localization was not possible in 46 cases. Our findings in this regard are shown in Table 4 and correspond to previous anatomic descriptions.

TABLE 5.—*Measurements of Biliary Duct System, Expressed in Millimeters*

	This Series		Partington and Sachs		Poppel and Associates	
	Range	Average	Range	Average	Range	Average
Right hepatic duct	3-17	7.93	....	4	....	3
Left hepatic duct	2-28	8.86	....	5	....	3
Common hepatic duct	3-34	12.29	....	5	....	5
Common bile duct	4-27	12.49	5-11	7	....	4.6
Transduodenal segment						
Length	8-20	13.01	....	10	10-15	..
Width	1-9	2.23	1-2	..	....	..
Papilla of Vater						
Length	6-20	11.89	....	..	1-30	15
Height	5-13	8.04	....	..	1-12	5
Pancreatic duct	1-12	3.5	....	..	2-4	..

When possible, measurements of the papilla of Vater and of the biliary ducts were obtained in all cases regardless of the presence or absence of pathology. These are compared in Table 5 with the normal measurements described by Partington and Sachs[15] and Poppel and co-workers.[16]

As has been pointed out by previous authors, the cystic duct may appear to the surgeon to center the common bile duct at right angles. Frequently, however, the cystic duct turns and runs almost parallel to the common duct for some distance before entering it. As a result, the common bile duct appears to be dilated, and transection of the cystic duct leaves a long stump as a site for future inflammation, stone formation, and symptomatic difficulty. The anatomy of the duct

system becomes obvious when an adequate cholangiogram is obtained.

Many anatomists have shown that the pancreatic duct opens separately into the duodenum in about 30% of autopsy cases, and a main pancreatic duct is absent in about 4% of cases. In such cases it is impossible to get filling of the pancreatic ducts on a cholangio-

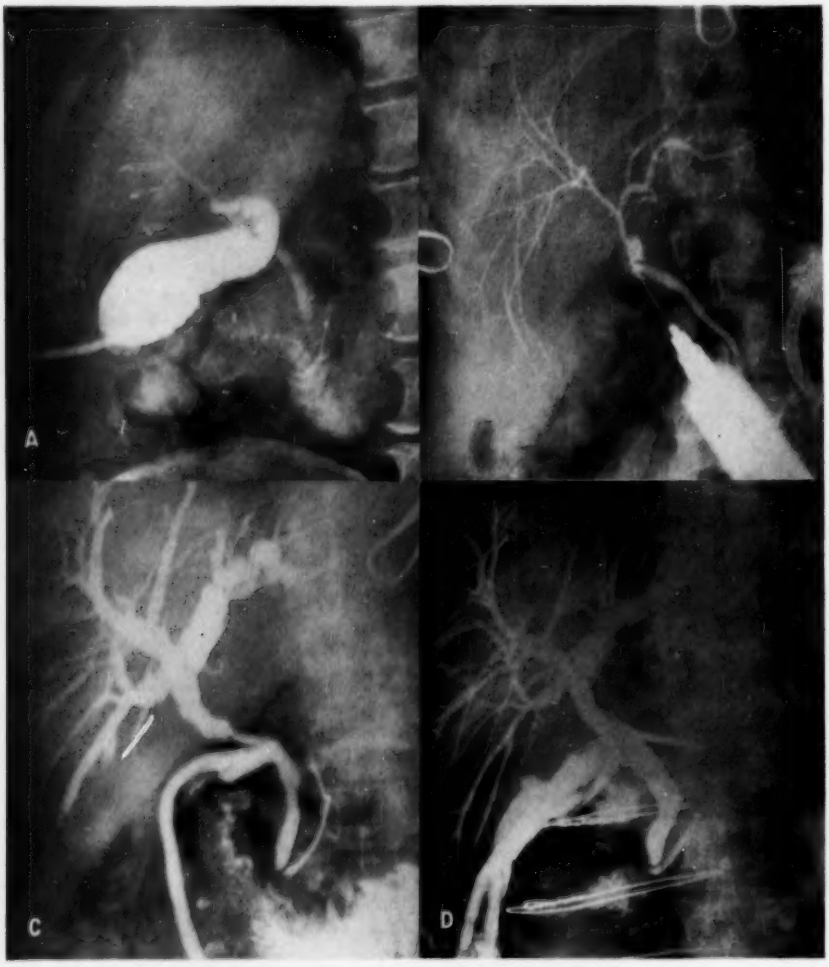


Fig. 1.—Normal cholangiograms.

A, via cholecystostomy tube postoperatively. Note that the hepatic ducts are incompletely filled and a portion of the common duct is obscured by the overlying neck of the gall bladder. This film is therefore unsatisfactory, but other films in the examination showed these areas to be normal.

B, via needle injection into the common hepatic duct prior to choledochotomy. There is slight extravasation of contrast agent at the site of injection, but not sufficient to obscure detail. The syringe overlies the distal common bile duct, and the examination is therefore not entirely satisfactory.

C, and D, via catheter in cystic and common bile ducts, operative postcholedochotomy and postoperative cholangiograms, respectively. There is good filling of the ducts. The eccentric curve of the transduodenal segment of the distal common bile duct in *C* is due to a sphincterotomy, which was performed to remove a stone from the ampulla. Also note branching of the right hepatic duct, as described in the text.

gram. We have noted filling of the pancreatic ducts to be rather unpredictable. We do not feel it is related necessarily to spasm of the sphincter of Oddi or to other irregularity of the papilla of Vater or transduodenal segment of the common bile duct. Its demonstration (Fig. 3) is probably a matter of individual chance, anatomy, and physiology at the time of injection.

Poppel and co-authors [16] list the etiologic factors in the abnormal cholangiogram as follows: (1) carcinoma of the Vaterian segment, (2) spasm of the choledochus sphincter, (3) calculus of the biliary system, (4) organic noncalculous obstruction above the ampulla by acquired or congenital stenosis of the sphincter of Oddi or by stricture of the common duct, (5) carcinoma of the head of the pancreas, (6) acute hemorrhagic necrosis of the pancreas, and (7) chronic pancreatitis. The last three categories are not included in this group of cases. To the first group we should like to add "or carcinoma of the biliary ducts," and this point will be discussed later.

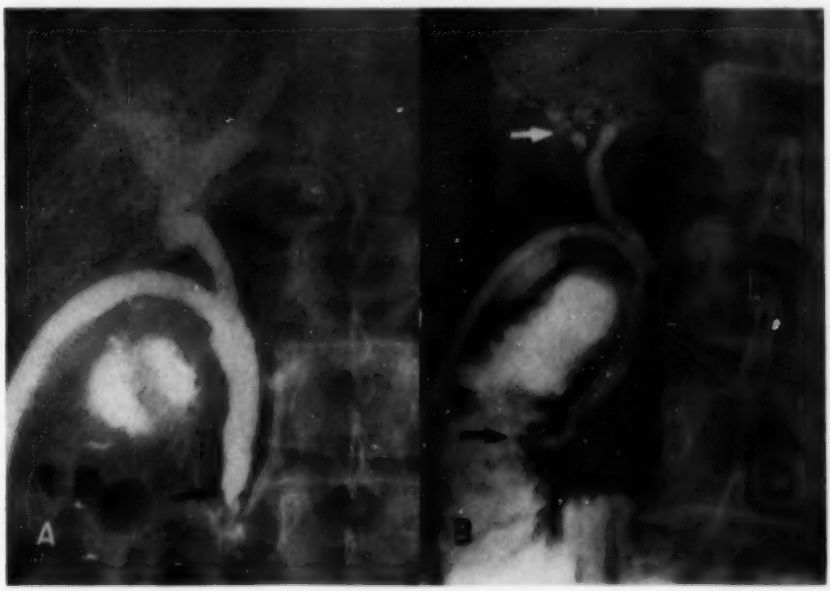


Fig. 2.—*A*, normal cholangiogram via catheter. Arrow points to cuff-like appearance of the proximal end of the transduodenal segment of the common bile duct, which should not be confused with adhesions or stricture. The pancreatic duct is also filled, and a small papilla of Vater is outlined.

B, normal cholangiogram. Hepatic ducts are not well filled but were well shown on other films. The white arrow is directed toward air bubbles in the right hepatic duct; the black arrow points to the papilla of Vater, seen in profile.

THE ABNORMAL CHOLANGIOGRAM

Calculi.—The common duct stone is by far the most frequent etiologic factor in the abnormal cholangiogram. Such stones are rarely found in patients who do not have calculi of the gall bladder and may be considered a complication or sequela of cholelithiasis. Partington and Sachs [18] discuss Bonn's findings in 1,000 necropsies, from which it was concluded that 25% of patients with gallstones would have stones in the common duct, and that 60% of these would be retroduodenal. This high incidence of stones in the distal common bile duct has been found by many authors on the subject. Likewise, this is the area where surgical exploration is often unsuccessful.[8] Stones in

this region are difficult to palpate, especially if the pancreas is large and hard and the stones small. A probe or scoop may by-pass a stone without detecting its presence, and intrahepatic stones are often beyond the reach of instruments. Procedures such as irrigation and suction are not infallible for the detection of stones. Buxton and Burk Jr.[2] report 61 of 199 cases of common duct stone in which the stones were not palpable but in which choledochotomy was performed for other reasons (jaundice, etc.). This represents a failure of surgical palpation of 30.6%. Corff and his associates [3] report 40% of patients with choledocholithiasis who did not have jaundice.

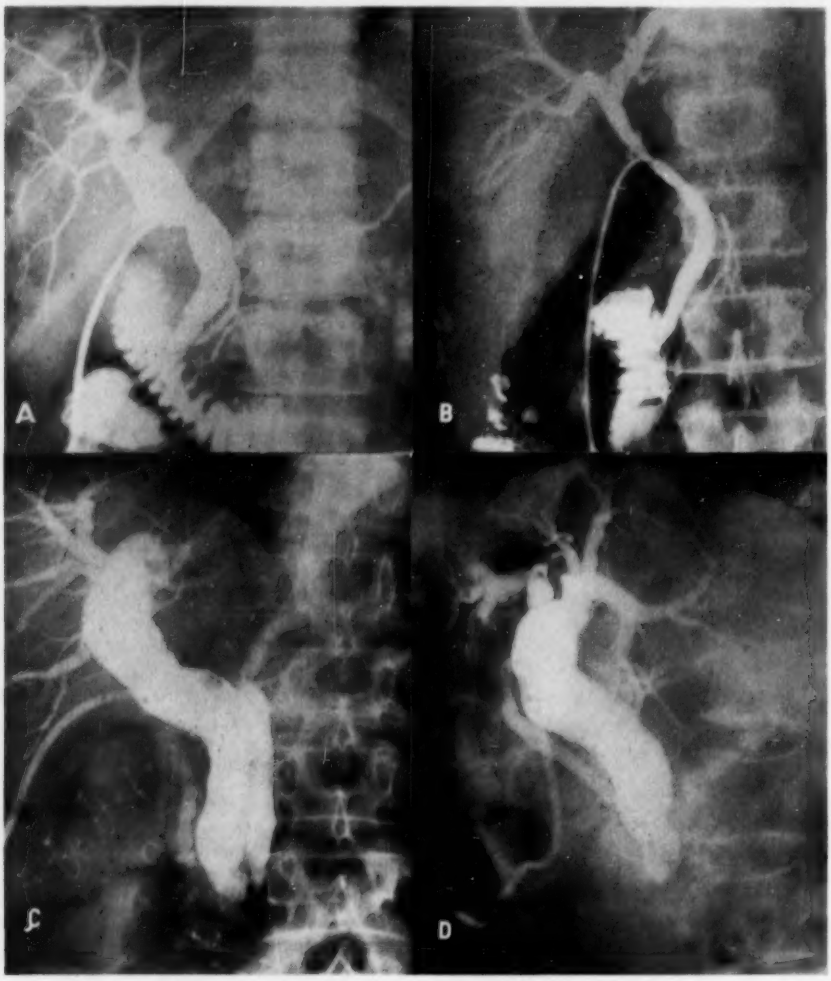


Fig. 3.—*A*, postoperative cholangiogram with filling of the pancreatic duct and its ramifications in the head of the pancreas. Residual dilatation of the hepatic ducts is present, following removal of many stones from the common duct.

B, normal postoperative cholangiogram with filling of pancreatic duct. The distal common bile duct and pancreatic duct were seen to join just proximal to the papilla of Vater.

C and *D*, anteroposterior and right lateral postoperative cholangiograms, showing markedly dilated pancreatic and common ducts with delayed emptying due to sphincteric spasm or partial obstruction. The patient has been followed for three years and has been relatively asymptomatic.

Stones of the biliary ducts are usually presented in the cholangiogram as areas of radiolucency of varying size and configuration. Differentiation from air bubbles is often difficult, but a few characteristics may aid in evaluation. If the radiolucent area has at least one straight, flat, or faceted margin, it is more likely to represent a stone (Fig. 4*C*). Similarly, multiple 1 to 3 mm., poorly defined radiolucencies are usually due to "biliary

Fig. 4.—Calculi. *A*, postoperative cholangiogram with complete obstruction of distal common bile duct by a convex defect due to a stone. Also note the rather long cystic duct stump and some extravasation along the drainage tract.

B, operative precholedochotomy cholangiogram via catheter in cystic duct showing crescentic defect in distal common bile duct due to a stone. This was not obstructing, as contrast agent emptied readily into the duodenum. Rather marked extravasation at the site of catheter insertion was also present.

C, operative precholedochotomy cholangiogram via needle and syringe. The hepatic ducts are dilated, and the irregular radiolucencies in the common bile duct represent calculi. Note the tapering of the distal common bile duct with little contrast agent in the duodenum, due to associated spasm.

D, operative postcholedochotomy cholangiogram showing very irregular small defects in the distal common bile duct due to small stones, débris, etc. ("biliary mud"). No delay in emptying or dilation of the ducts was present.

mud" (Fig. 4*D*), and not air. Stones can change position in the ducts during cholangiography, as do air bubbles, but the direction of motion relative to gravity and change in position is of importance. For example, if a radiolucency moves from the distal common bile duct to the common hepatic duct when the patient is moved from a Trendelenburg to a supine position, then the radiolucency is more likely to represent an air bubble which is seeking the higher level.

A duct containing stones is usually, but not always, dilated, whether or not obstruction is evident (Fig. 4A and B). An obstructing stone most commonly produces a rounded, crescentic margin projecting convexly into the column of contrast agent. Larger stones produce an almost hemispherical defect (Fig. 4*A*). Occasionally, a complete obstruction of a duct will be manifest by a sharp, flat cut-off in the contrast column. This is especially true in the small intrahepatic ducts. Norman [14] states that incomplete filling of one branch of a hepatic duct is an indirect sign "strongly suggestive of stone" if filling of the remainder of the hepatic tree is good. Not infrequently stones will be lodged against and embedded in one wall of the common duct and thus will be seen as punched-out hemispherical or faceted defects. Spasm of the sphincter of Oddi is often associated with common duct stones; this will be described later.

In the present series, there are 40 cases (74 cholangiograms) with roentgenographically demonstrable stones. Fifteen of these cases (21 cholangiograms) showed complete obstruction. Of the 139 cases in which choledochotomy was done for stones or clinical question thereof, 12 had demonstrable stones postoperatively. This is an incidence of 9%. One of these patients had stone demonstrated on two postoperative occasions. These were removed each time, so that the patient underwent three choledochotomies in the course of 15 months.

Saragelui's first report [19] was of five cases with postoperative retained stones. Young,[21] in 1929, reported autopsies on 67 patients who died after biliary tract surgery; 44 of them showed stones of varying size. He placed the percentage of failure at "16.4 to 61.3 depending on the optimism or viewpoint of the surgeon." Mixter and co-workers [13] found retained stones after choledochotomy in 13%, and Corff and associates,[8] in 50% of operative (exploration of common duct) postcholedochotomy cholangiograms. The latter group, however, found postoperative retention of stones in 18%. Hicken and associates [7] reported residual stones in 12% and Buxton and Burk [2] in 6% to 13% (depending on how their statistics are analyzed). Norman [14] reports an incidence of retained stones in 10% of choledochotomized patients. In 26 of the 33 cases he presents in this group the stones were in the intrahepatic portions of the duct system.

Although cholangiograms consistently will reveal stones that might be overlooked otherwise, they are not infallible. Stones can be obscured by contrast agent, especially in a widened and dilated duct. Mixter and associates [13] report 9 false-negative and 5 false-positive cholangiograms in 113 examinations done before surgical exploration. In their postoperative group, they report that a normal cholangiogram was followed by reexploration or autopsy demonstration of biliary duct stones in 4.9%.

Air Bubbles.—As has been mentioned earlier, air bubbles are very disturbing in the differential diagnosis of calculi. Such air collections were present in 23 cases (29 cholangiograms) of the present series. This represents 7.18% of all cholangiograms. However, when these figures are broken down further, we find that air bubbles were present in 3.5% of the operative cholangiograms and in 10% of the postoperative group. Apparently, this discrepancy is related directly to the care exercised in avoiding this problem.

Air bubbles usually present as rounded, occasionally ovoid, radiolucencies that change in position, usually seeking higher levels (Figs. 2*B* and 5*B*). They should always be suspected if radiolucencies are also seen in the draining catheter or T-tube through which the contrast agent is introduced (Fig.

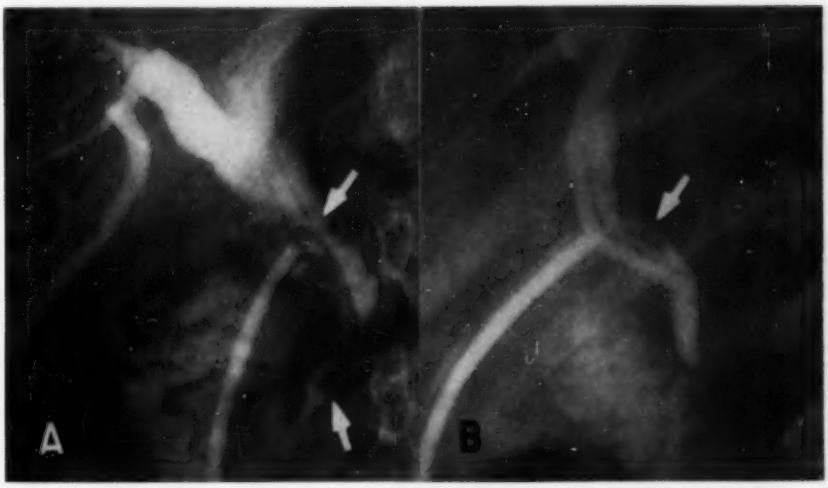


Fig. 5.—Air bubbles. *A*, postoperative cholangiogram via T-tube. The upper arrow is directed toward an air bubble in the T-tube at the junction of the T. The lower arrow points to a rounded radiolucency in the lower common bile duct, which was a large air bubble.

B, postoperative cholangiogram. Three rounded radiolucencies at the arrow were due to air bubbles in the common bile duct.

5*A*). One must remember, however, that the presence of air in the bile ducts does not necessarily preclude the presence of stones. We feel that all cholangiograms demonstrating air bubbles should be repeated with adequate precautions to prevent recurrence of the bubbles.

Spasm.—Somewhat prolonged spasm of the sphincter of Oddi sufficient to raise the question of obstruction was seen in a total of 35 cases, as shown in Table 6. As can be seen, the incidence of such spasm was almost three times as high in the operative cholangiograms (17.54%) as in the postoperative studies (6.44%). Such spasm has been described § as being due to too rapid injection of contrast agent, to injection of too cool a solution, to psychogenic factors, and to the use of morphine. The last is probably the most feasible explanation of the incidence of this phenomenon in the operative and postoperative cholangiograms.

TABLE 6.—*Spasm of Sphincter of Oddi*

	Cases,	Cholangiograms	
	No.	No.	%
Operative	24	30	17.54
Postoperative	11	15	6.44

The picture of spasm is that of an abrupt narrowing and tapering of the distal portion of the opacified common bile duct at the region of the transduodenal segment (Fig. 6). Emptying of contrast agent into the duodenum is usually not discernible on the first film, but subsequent films will show small amounts of contrast substance in the small bowel. Prolonged spasm, such as that associated with stones in the common bile duct, usually also presents some dilatation of the ducts.

Stricture.—Nine cases of stricture of the common bile or hepatic ducts are included in this study, although in only six cases were cholangiograms done to demonstrate this pathology (Tables 1 and 2). In each of these six cases complete obstruction was demonstrated. Such stricture is due to previous surgical exploration and choledochotomy in a large proportion of cases.[10] It is manifest on the cholangiogram by an abrupt, flat, and blunted obstruction of the opacified duct, which is dilated above the site of obstruction. Occasionally the corners of the obstructed

§ References 13, 15, and 16.

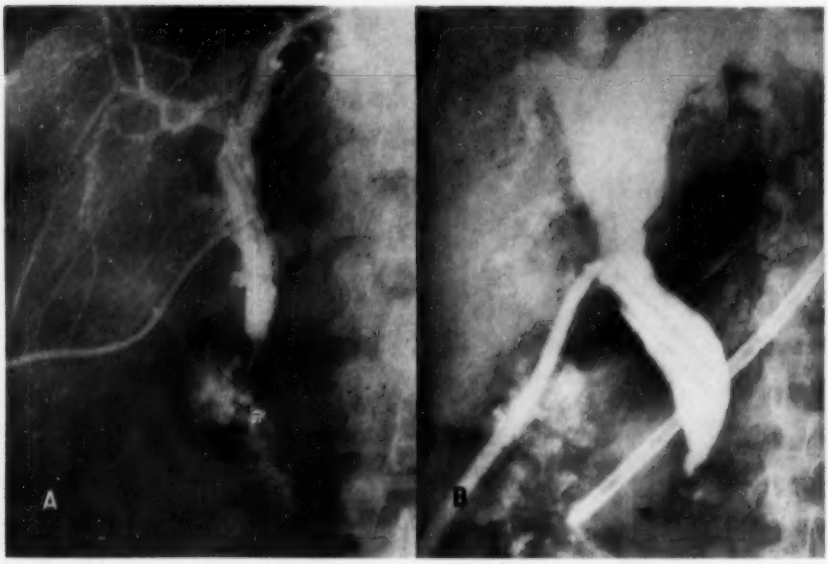


Fig. 6.—Spasm of sphincteric portion of the common bile duct. *A*, postoperative cholangiogram with tapering of the distal common bile duct and poor emptying into the duodenum due to spasm. There is slight dilation of the common ducts. Photograph is slightly retouched.

B, operative postcholedochotomy cholangiogram via T-tube showing marked dilation of the biliary ducts with tapering of the distal portion and practically no emptying. Stones had been removed previously, and subsequent duodenostomy was negative.

end are slightly turned so that the margin of the opacified duct is convex distally (Fig. 7). This is the reverse of the curve produced by an obstructing stone.

Fig. 7.—Stricture of common bile duct with almost complete obstruction. Note the convex edge of the contrast column at the site of obstruction, as compared with Figure 4*A* and *B*.

Stricture of the transduodenal segment of the common bile duct presents a picture which is identical with that of spasm. Eccentricities of the duct in this region may be related to stricture or pancreatic abnormalities.|| Similar changes may be encountered with marked edema of the duodenal wall or after sphincterotomy.

Tumor.—Neoplasms of the biliary ducts are not frequently demonstrated cholangiographically. In the present series, eight cases of tumor were demonstrated, or 5.06% of all cases. Of these, seven, or 4.43%, of cases were carcinoma (Table 1). The very poor survival rates for patients with carcinoma of the biliary tract are apparently related to the marked progression of the disease before a diagnosis is made.[4]

The case of ampullary carcinoma presented is a case in point.

This patient was operated upon in February, 1952, for signs and symptoms suggesting a low-grade biliary obstruction. Cholecystograms showed non-

|| References 15 and 16.

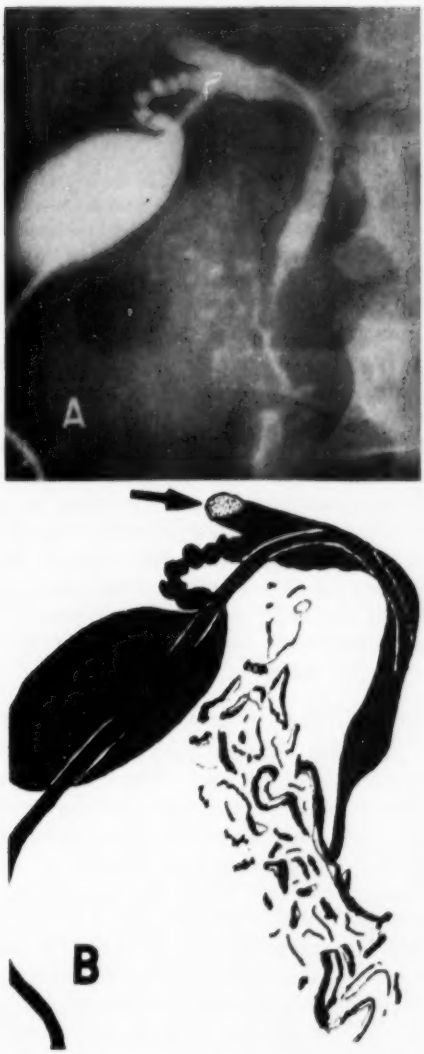
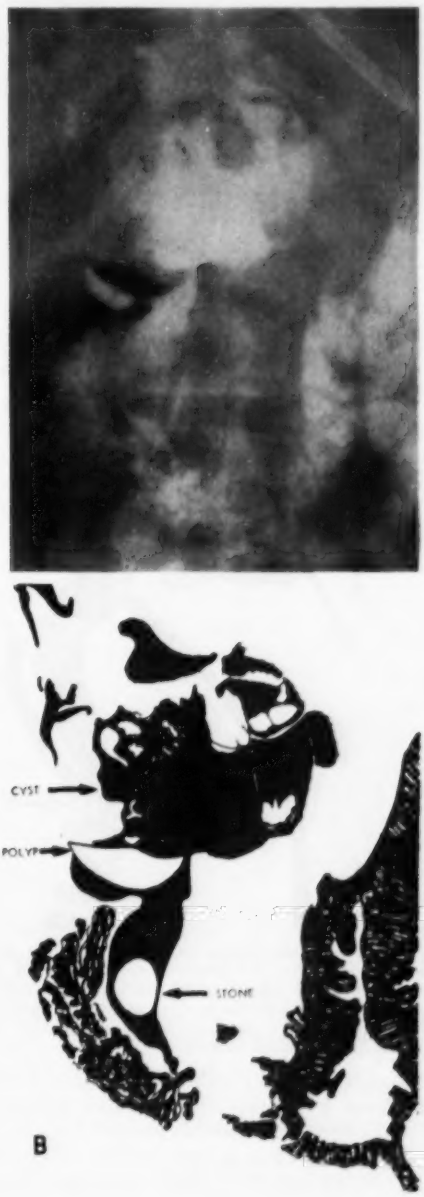


Fig. 8.—Carcinoma of common hepatic duct. There was nonfilling of the right and left hepatic ducts in four separate cholangiograms with a normal-appearing common bile duct. Note the filling defect in the common hepatic duct (at arrow in tracing, Fig. 8*B*), which could be an obstructing calculus. Postmortem examination revealed a polypoid obstructing carcinoma of the common hepatic duct 2 cm. proximal to the entrance of the cystic duct.

visualization. Exploration was negative. A cholangiogram showed some delay in emptying, but because a catheter could not be passed into the duodenum, a duodenotomy was performed and the sphincter dilated with probes. A T-tube was then put in place, and a second cholangiogram appeared to be normal.

Fig. 9.—*A*, operative precholedochotomy cholangiogram with a bizarre collection of contrast agent in the hepatic region and two radiolucent defects.

B, is a tracing of same. Exploration revealed a 2 cm. calculus in the distal common bile duct and a 4 by 6 cm. movable polyp on a pedicle in the left hepatic duct. Proximal to the polyp was a huge 10 cm. choledochal cyst, which is incompletely filled on this examination—hence the bizarre collections of contrast agent.



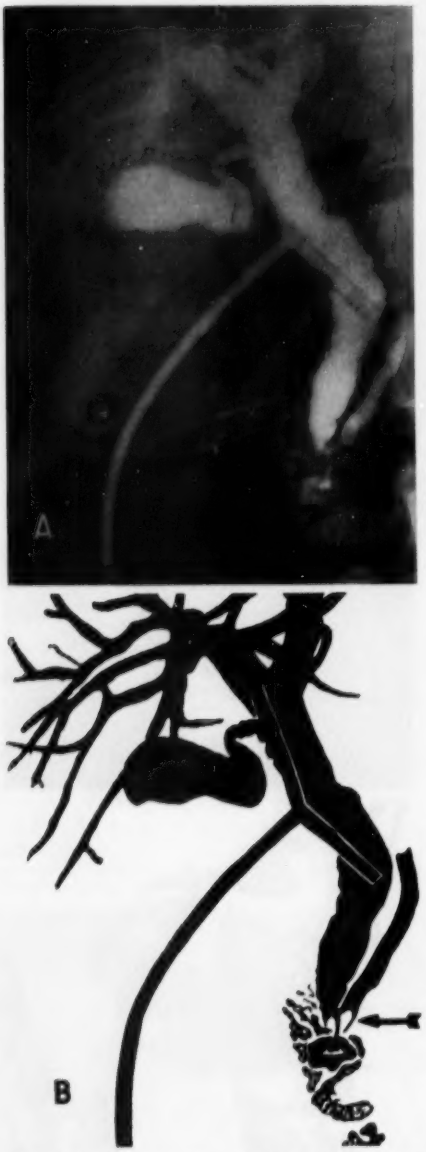


Fig. 10.—Postoperative cholangiogram (*A*) and tracing of same (*B*) showing polypoid defect in pancreatic duct (arrow) and similar defect in the distal common bile duct. The lesion was pathologically reported as "carcinoma of ampulla of Vater," as described in text.

served until the patient was readmitted in January, 1953, for complaints similar to the initial admission. Surgical exploration at this time included a spincterotomy, which disclosed two tags of papillomatous tissue at the sphincter. Grossly, these appeared to be benign, and there was no evidence of extension. Histological study of the biopsy specimen, however, showed this to be carcinoma of the ampulla of Vater. Subsequent radical pancreaticoduodenal resection failed to reveal any further evidence of tumor. This case, then, is an example of a very slowly growing tumor, which should have been removed 11 months earlier if the roentgenographic findings had been properly evaluated.

Twelve days later a cholangiogram made in the Radiology Department showed peculiar filling defects in the distal common bile duct and in the distal pancreatic duct just at their juncture (Fig. 10). This finding was not given the significance it de-

The cholangiographic demonstration of tumor of the bile duct varies. Commonest in this series was the demonstration of a filling defect similar to that seen with tumors of the intestinal tract. This, however, cannot be distinguished from calculi very readily (Fig. 9). At times the picture of obstruction will be presented, as seen in five cases in this group (Fig. 8). The differential diagnosis cannot always be made, but an explanation of all pathology demonstrated on the cholangiogram should be sought diligently.

CRITERIA FOR AN ADEQUATE CHOLANGIOGRAM

The ideal cholangiogram should outline the entire biliary tract. This means that there should be good filling of the tract from the smallest hepatic radicle down to and including the transduodenal segment of the common bile duct, unless there is pathology to explain satisfactorily any lack of visualization. We appreciate only too well that this is not always possible in practice. However, it is felt that the technique of cholangiography can be evaluated only if such strict criteria are used.

Mixter and associates [13] report 20 unsatisfactory examinations of 280 operative cholangiograms. Of these, 6 had catheters extending into the duodenum; 2 had motion; 2 had leakage of contrast agent, and 10 had superimposed shadows, incomplete filling, and/or poor exposure. Hunt and associates [10] describe unsatisfactory cholangiograms as due to roentgen technical factors, extravasation, and obscuration of stones due to the density and quantity of contrast agent used. However, no statistics are submitted in this

regard. Norman [14] had 18% unsatisfactory studies "due to various reasons," which are not enumerated. These cases were not included in the evaluation of the large series which he reported. Hicken and co-workers [7] state that the commonest oversight is failure to fill all the bile ducts, and also to mention air bubbles as disturbing to proper evaluation. Again, statistics are not offered. Hight and Lingley [9] report 83.4% satisfactory studies of 115 operative cholangiograms. They, too, fail to list criteria, however. Partington and Sachs [15] describe 10% of their 150 cases as unsatisfactory and another 10 to 13% with "technical shortcomings," which are not further explained.

We have reviewed our series of 405 cholangiograms, the main criterion for a satisfactory examination being that of "visualization of the entire biliary tract (other than the gall bladder and cystic duct) with defects in this visualization adequately explained pathologically." In this regard, strict requirements for roentgen technical factors were not used. Likewise, air bubbles were not included in the unsatisfactory category outlined in Table 7. Extravasation of contrast agent is often present in minimal degree at the site of injection or tube insertion. Only when this obscured a part of the bile ducts was it considered sufficient to classify an examination as unsatisfactory.

TABLE 7.—*Unsatisfactory Cholangiograms*

Reason	Operative	Post-operative
Hepatic ducts not well filled	24	25
Transduodenal segment not seen	20	17
Hepatic ducts and distal bile duct not seen	15	8
Catheter in duodenum	9	13
Miscellaneous	14	17
Total unsatisfactory	82	80
Total examinations	171	234
% Unsatisfactory	48.0	34.2

As seen in Table 7, there are two major oversights in the cholangiographic study, both of which are really due to inadequate examination. Lack of filling of the hepatic ducts (Fig. 1*A*) accounted for almost half of all unsatisfactory examinations in both the operative and the postoperative group. A close second for incompleteness of the examination was the lack of visualization of the transduodenal or sphincteric segment (Fig. 1*B*). If the tip of the drainage tube extends into the duodenum, good filling of the bile duct is usually precluded, and well nigh impossible. Occasionally, however, surgical indications require such a placement of the drainage tube. It will be noted that, although the percent of unsatisfactory studies is very high, the postoperative examination rate of 34.2% is significantly better than the unsatisfactory operative rate of 48%. We feel that this is at least partially accounted for by the fact that fluoroscopy was used in practically all the postoperative examinations. It should also be noted that this is a rate of unsatisfactory cholangiograms, not cases. If cases were used as the basis of study, the unsatisfactory rate would be much less, since many cases had repeatedly poor examinations. The water-soluble contrast agents are much preferred to the halogenated oils which were used in some of these cases and are especially unsatisfactory for filling the smaller hepatic radicles.[12]

The incidence of unsatisfactory examinations is shockingly high, but probably no higher at this hospital than it is in most sections of the country if one uses our criteria. This we believe to be due to the lack of real interest in the procedure by both surgeon and roentgenologist. As with any other procedure, a lackadaisical attitude immediately decreases the information obtainable from that method. It is this attitude which accounts for the large group of cases with inadequate filling of the biliary tract and for the lack of visualization of the sphincteric portion of the common bile duct. The latter can be demonstrated easily if the patient is turned into a slight right posterior oblique position. The use of large quantities of contrast agent is unnecessary. With the procedure outlined below, a total of 30 cc. of contrast agent should be sufficient for the most dilated duct system.

RECOMMENDED TECHNIQUE

As a result of this investigation, the technique for cholangiography outlined below

has been instituted at The New York Hospital, in the hope of removing the many faults, inadequacies, and discrepancies described above. Again, it must be said that how effective this routine will be will depend on the conscientiousness of the surgeon and the roentgenologist involved. Close cooperation among surgeon, roentgenologist, and anesthetist is essential. A closed endotracheal system of anesthesia is preferred for the operative cholangiograms in order to have adequate cessation of respiration during the exposure. Roentgen exposure should be made as short as possible, and a relatively high voltage technique (80 to 90 kv.) is preferred. Films are taken with a Bucky tray, or at least a grid cassette. Of course, opaque surgical instruments must be removed from the area. As already mentioned, the water-soluble contrast agents are used, and, as will be seen, we prefer a fractional system of injection of contrast agent.[1]

The present routine calls for a precholedochotomy operative cholangiogram and a postcholedochotomy operative cholangiogram, as well as a postoperative cholangiogram. It is hoped that with this type of study, and with more adequate examinations, a truer evaluation of the cholangiogram per se will be obtained. A syringe and needle are used to inject the contrast agent into the duct or drainage tube in the hope of avoiding air bubbles more readily than with an adapter or funnel. However, extreme care must be taken that all air bubbles are removed from the tube before it is clamped and before the contrast agent is instilled.

The procedures used at the present time are as follows:

1. Operative Precholedochotomy Cholangiogram

(*a*) After cholecystectomy or after clamping the cystic duct, and with the patient in a 15-degree Trendelenburg position, 5 to 15 cc. of contrast agent is injected via a long, short-beveled needle inserted into the common bile duct or common hepatic duct and a film taken immediately. This is to fill the left and right hepatic ducts and their tributaries.

(*b*) Then, without the needle being removed from the duct, and with the patient in a supine position, another 5 to 15 cc. of contrast agent is injected and another film taken.

(*c*) The developed films are examined, and if the distal common bile duct and/or the sphincteric area are obscured by contrast agent in the duodenum, the patient is turned to his/her right oblique position, another 5 to 15 cc. of contrast agent is injected, and another film is taken.

(*d*) This procedure should outline the entire biliary tract, from the small hepatic radicles up to and including the sphincter. If there is no emptying into the duodenum seen on the films without obvious cause, a delayed film should be taken.

2. Operative Postcholedochotomy Cholangiogram

(*a*) This procedure is preferably done via a T-tube whose arms are not too long and do not extend into the duodenum unless surgically indicated.

(*b*) The T-tube-biliary tract system must be water-tight. A solid flow of bile against gravity (tube elevated) is probably the best way to rid the tube of air. The tube is then clamped and contrast agent is injected via a needle in the T-tube, using the same procedure as for the precholedochotomy cholangiogram.

(*c*) If a solid flow of bile is not obtained, the T-tube is flushed thoroughly with saline and the tube clamped while the solution is still being injected. The procedure is then continued as previously directed.

3. Postoperative Cholangiogram

(*a*) This procedure is done two or three days before the T-tube is to be removed, to permit adequate time for the roentgenologist to study the films and for his report to reach the surgeon before removal of the tube.

(*b*) Again, an air-free tube-biliary tract system is essential. Therefore the tube should be clamped as described under 2*b* before the patient is sent to the radiology department.

(*c*) Injection of contrast agent is again made via a needle injected into the drainage tube and under fluoroscopic control.

(*d*) With the patient in the Trendelenburg position, injection is made slowly in order to fill the radicles of the left and right hepatic ducts. Left and right oblique positions may be necessary to accomplish this.

(*e*) The table is then put in its horizontal position and more contrast agent is injected to fill the remainder of the biliary tract. Usually a total of 20 to 40 cc. of contrast agent will be needed.

(*f*) A spot film is then taken with the patient in the left, and also in the right, posterior oblique position. Also, using the pressure cone, multiple spot films of the sphincter area are taken, one 8 by 10 in. film usually being used for this purpose.

(*g*) After fluoroscopy, 11 by 14 in. films of the right upper quadrant are taken with the patient in

the anteroposterior and right posterior oblique positions, with additional films as indicated by the fluoroscopist.

(*h*) All films are examined immediately before the patient is taken off the table to be sure that the examination is satisfactory.

CONCLUSIONS

A review of 171 operative and 234 postoperative cholangiograms is presented and the normal anatomy and measurements of the biliary tract partially elaborated. Of these, 96, or 23.76%, of the cholangiograms demonstrated abnormalities, which were due to stones in 40 cases, tumors in 8 cases, stricture in 6 cases, and a choledochal cyst in 1 case. The roentgenographic differentiation of these conditions is also reviewed. Spasm of the sphincter of Oddi was found to be almost three times as frequent in the operative cholangiograms as in the postoperative ones. The significance of this is discussed, as are the various etiologic factors for this phenomenon. Air bubbles were found more frequently in the postoperative studies, and methods of avoiding their occurrence are suggested. Eight cases of tumor, seven of them carcinoma, are included in this study. The diagnosis of tumor per se cannot be differentiated always from stones, but any abnormality in the cholangiogram should be thoroughly investigated. Although there were 40 cases with biliary duct stones demonstrated, only 15 of these showed obstruction of the duct. Occasionally stones can be differentiated from air bubbles, but more frequently this is not the case, and a repeat examination is necessary for proper evaluation. Postcholedochotomy stones were found in the biliary ducts in 9% of cases with stones or clinical question thereof.

This study of 405 cholangiograms, representative of 158 cases, has led us to the conclusion that cholangiography is of definite value and an important addition to the surgeon's diagnostic armamentarium. We believe the indications for cholangiography should be at least the same as those used for common duct exploration. For practical purposes, it is not expedient to do a cholangiography in all cholecystectomy cases, as has been suggested by other writers. It is our opinion that the value of cholangiography is directly related to the care with which the films are studied. Cooperation among surgeon, roentgenologist, and anesthetist is essential. A technique for operative and postoperative cholangiography is presented, using a fractional method of instillation ¶ of a water-soluble contrast agent [12] via a syringe and needle inserted into the duct or drainage tube. We know that some small stones will be obscured by the contrast agent, but we hope that the high-kilovoltage technique will decrease the incidence of such false-negative examinations. It is hoped that the incidence of unsatisfactory examinations (48% of the operative and 34.2% of the postoperative cholangiograms) will be greatly diminished by this procedure. The authors believe that well over 90% of cholangiograms should provide adequate visualization of the entire biliary tract with all abnormalities adequately explained pathologically.

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INVAGINATION TECHNIQUE FOR URETHRAL RECONSTRUCTION

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THE UROLOGY service of the General Hospital of México, D. F., is frequently confronted with patients suffering from traumatic or inflammatory stenosis, with partial loss of the urethra. Till recently we had been unable to offer a satisfactory solution to such patients. Near the end of 1950, a paper by A. W. Badenoch,[1] an English surgeon, appeared wherein a new technique for the reconstruction of the urethra was explained. He called it the "pull-through operation," and I have denominated it the "invagination technique." Its author recommends it for post-traumatic stenosis and up to the time of publication had performed it on seven occasions upon five patients (two with reoperation), having obtained good results.

In summary, Badenoch's technique consists of a primary suprapubic cystostomy through which the proximal or posterior portion of the urethra is located. The patient is placed in the lithotomy position, and a metallic sound is introduced through the meatus up to the site of stenosis. A member of the operating team holds the sound in place. With this as a reference, a vertical incision is made in the perineum extending from the bulbous urethra to 1 or 2 cm. in front of the anal sphincter. This permits dissection of the anterior portion of the urethra to an extension of 5 to 7 cm. and allows for a segment of this portion to be introduced into the previously located posterior portion of the urethra, into which a metallic sound has been introduced through the suprapubic cystostomy. To facilitate the introduction of the anterior portion into the posterior portion, the following manipulations are done: a Nelaton catheter is introduced into the anterior portion and sutured to the urethra. The other end of this catheter is fixed to the tip of the metallic sound that protrudes through the posterior portion of the urethra in the perineum. Then the metallic sound is taken out through the suprapubic cystostomy, drawing with it the Nelaton catheter, which, in turn, causes the anterior portion to invaginate into the posterior portion of the urethra. The Nelaton catheter is fixed to the abdominal wall, producing sustained tension during 10 to 12 days, which is sufficient for effective invagination.

I have practiced the operation with some modifications that I have considered of importance for obtaining better results:

1. Cystostomy for efficient urinary drainage done one or two months beforehand.

2. Incision similar to that advocated for perineal prostatectomy: that is, a curved incision concave inferiorly that extends from one ischium to the other at approximately 2.5 cm. in front of the anus. Dissection of the ischiorectal fossae to either side of the rectourethral septum, pushing the superficial transverse muscle forward and maintaining a clear operating field that will enable an easier identification and better dissection of the posterior portion of the urethra than can be achieved by the vertical incision alone (Fig. 1).

3. Through the suprapubic cystostomy, a metallic sound is introduced into the posterior portion of the urethra to locate it in the perineal operating field. On some occasions, the posterior segment extends as far up as the membranous urethra, but on other occasions, only to the prostatic urethra. The posterior portion must be dissected as completely as possible. The urethra is reopened and dilated with Hegar dilators, No. 10 or 12, leaving them 15 to 20 minutes, and in the

Read before the Section on Urology at the 103rd Annual Meeting of the American Medical Association, San Francisco, June 24, 1954.

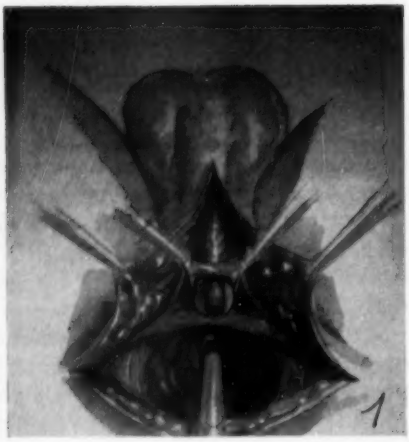


Fig. 1.—One can observe the Hegar dilator introduced in the posterior portion of the urethra while the dissection of the bulbous urethra is undertaken.

meantime the anterior portion of the urethra is prepared for invagination.

4. A metallic sound is introduced through the meatus down to the site of stenosis and serves as a guide for the vertical incision of 6 cm. which extends into the previous transverse incision. This allows one to resect retractile scar tissue interposed between the anterior and posterior portions of the urethra and to dissect the anterior segment for its invagination into the posterior segment by liberating the spongioid urethra in an extension of 5 to 6 cm.

5. A Nelaton rubber catheter No. 12 or 14 is introduced 3 or 4 cm. into the posterior opening of the anterior segment and fixed to the walls of the urethra by two absorbable surgical (gut) No. 1 sutures. This will permit a means for moderate tension on the anterior segment which can thereby be introduced into the posterior segment by adapting the catheter onto the metallic sound and passing it out through the cystostomy inci-

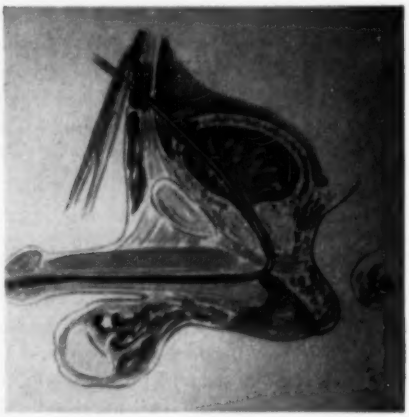


Fig. 3.—The Nelaton catheter is sustained over the cystostomy wound by means of a Pean forceps which maintains moderate traction.

Fig. 4.—The uretrocystogram shows complete post-traumatic stenosis and existence of a perineal fistula.

Fig. 2.—Once the Nelaton catheter has been fixed to the anterior portion, it is introduced into the posterior portion of the urethra and withdrawn through the cystotomy wound by mounting it on a metalic sound that had previously been introduced through the bladder into the posterior portion of the urethra.

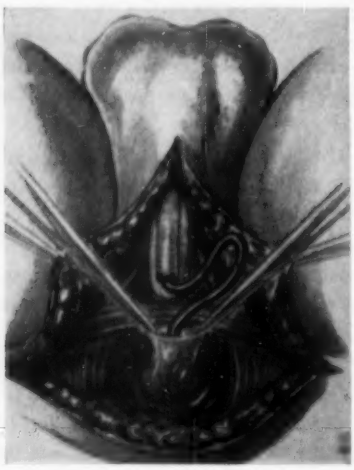


Fig. 5.—The same case three months after the operation.

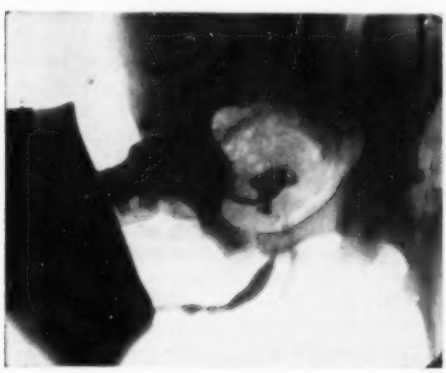
sion. Then the urethral walls and periurethral tissues are sutured together with three absorbable surgical No. 1 (gut) sutures. The Nelaton catheter is sustained by a pressure forceps on the abdominal wall.

6. A Pezzer catheter is placed through the cystostomy into the bladder for urinary drainage. The perineal wound is closed in layers, leaving a Penrose drain at the lowermost point.

The Nelaton catheter is spontaneously freed 10 to 12 days after the operation and advantageously used as the intravesical catheter during the healing of the suprapubic cystostomy wound.

Most of our patients are seen months or years after the pelvic trauma; some already have a suprapubic cystostomy done in previously unsuccessful attempts to repair the urethra. On others, cystostomy has been practiced as the first step in initiating the study. Cystostomy serves two purposes: first, it allows the urethra to remain practically at rest for one to two months, and, second, it provides a better conditioning for the tissues, thereby affording an easier surgical procedure and smoother postoperative evolution.

Fig. 6.—Urethrocystogram of a rectourethral fistula.



PREPARATION AND TECHNICAL DIFFICULTIES

In all the cases, I have obtained urethrocystographies before and after the operation, following Flock's technique and excretory urograms. I also established the rule of having urine cultures for the identification of the type of infectious agent present before the operation, although antiseptics and antibiotics are administered as a prerequisite for one or two weeks before the scheduled plastic operation anyway.

Fig. 7.—The same case after operation.

The most important technical difficulties are encountered in the presence of infection of the bony pelvis, especially the pubis or ischium, and this problem must be dealt with before proposing the reconstruction of the urethra.

The dissection of the spongioid uretha presents now and then some difficulties. These are more likely to arise when one is dissecting free the posterior wall, a procedure which, when possible, should be done up to the penoscrotal angle, for this facilitates the drawing back of the urethra. It is also helpful to dissect the posterior segment well; this can be accomplished more easily by introducing a Foley catheter through the posterior

segment into the bladder and inflating the balloon with 10 cc. of water, permitting this segment to be drawn forward into the middle of the operating field. This can be accomplished by simple traction with an Allix clamp.

INDICATIONS

The chief indication for this procedure is in rupture of the urethra due to pelvic trauma, wherein the classical techniques have failed and where the principal difficulty lies in a destruction of a part of the perineal urethra with intervening retractile scar tissue that makes catheterization impossible. Dr. Badenoch proposes his technique precisely for these cases, and I have extended its use to inflammatory stenosis if and when the penile and the spongioid urethra maintain a useful caliber. I have practiced this operation in one case of congenital rectourethral fistula.

RESULTS

The majority of the patients presented stenosis impossible to catheterize. Some presented perineal fistula with partial destruction of the urethra and, especially, the membranous portion of the urethra.

Ten patients had post-traumatic stenosis with fracture of the pelvis; 7 had inflammatory stenosis, and 1 had the congenital rectourethral fistula mentioned previously. The postoperative evolution was slow in the majority of the patients, for they stayed in the hospital more than two months and required catheterization once a week at the beginning; some have been catheterized every three or four months during the two years following the operation. This procedure has been carried out without difficulty in all the cases. Three of our patients needed to be reoperated on.

I have been able to follow up most of these patients periodically and know that the majority in this group presented disturbances of their sexual function, but with time, they have obtained almost complete recovery.

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HEMORRHAGIC TENDENCY IN POLYCYTHEMIA VERA

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POLYCYTHEMIA vera is characterized by both spontaneous thrombosis and hemorrhage. In general, the thrombotic tendency has been stressed, and relatively little emphasis has been placed on the hemorrhagic aspect. Burris and Arrowsmith [1] have recently published their experience with surgery on 68 patients with polycythemia vera. This is the only report in the recent surgical literature which has discussed this problem. They found the thrombotic tendency to be the most common postoperative complication and did not list any instance of hemorrhage. The purpose of this paper is to present a case of polycythemia vera in which the postoperative course was complicated by hemorrhage and to suggest a more comprehensive preoperative evaluation which would help prevent both hemorrhagic and thrombotic complications.

REPORT OF A CASE

The patient, C. N., a 61-year-old man, had had polycythemia vera for 10 years controlled by phlebotomy and P^{32}. During the past few years he had developed severe secondary thrombophlebitis, varicose veins, and leg ulcers. He responded poorly to conservative therapy, and high saphenous vein ligation was recommended. On admission he was noted to be a thin, plethoric white man in no acute distress. Pulse rate, 80; regular sinus rhythm; blood pressure 140/90. Physical examination revealed marked hepatosplenomegaly and distention of the superficial abdominal and leg veins. Both legs showed pigmentation, 2+ pitting edema, and scars of previous ulceration; an area of ulceration on the left leg and large areas of impending breakdown over the right pretibial region were found. Peripheral pulsations were normal. There were no petechiae, hematomata, or other signs of bleeding tendency. On admission hemoglobin was 14.3 gm. per 100 ml.; red blood cells 5,600,000; white blood cells, 15,900; segmented cells, 79%; band forms, 7%; eosinophiles, 2%; monocytes, 2%. With the patient under local anesthesia, the right saphenous vein and its major tributaries were ligated close to the femoral vein. Considerable attention was paid to careful technique and hemostasis. Despite this, 24 hours later the patient was found to have a large hematoma, and bright red blood was seen oozing from the wound. Laboratory examination revealed a normal bleeding time, clotting time, and prothrombin time, but it was noted that the clot did not retract and was easily dispersed. The hematocrit reading was 58%; sedimentation rate, 1 mm. corrected, and platelet count 729,300.

He was taken to the operating room and under thiopental (Pentothal) anesthesia the hematoma was evacuated. On careful inspection no bleeding points could be found. There was a constant ooze of bright red blood from the entire surface of the raw area. Suture ligatures were placed in the areas of most active oozing and oxidized cellulose (Oxycel) and thromboplastin were placed over the raw edges. A ½ in. (1.2 cm.) packing was introduced and the incision closed with interrupted nonabsorbable surgical (silk) sutures. The patient was ordered on complete bed rest and 15-degree Trendelenburg position. A sandbag was put over the wound dressing. Despite these measures, the hematoma continued to spread into the thigh and scrotum and the wound continued to drain red blood. We felt that this hemorrhage was related to the polycythemia vera and would best be controlled by attacking the primary disease. Daily phlebotomy was performed until the hematocrit value dropped to 46%. After six days the oozing stopped and the packing was removed. The hematoma absorbed, and the wound closed gradually without further complication.

COMMENT

Bleeding in patients with polycythemia vera is not rare. Tinney and co-workers studied 163 patients with this disease and found hemorrhagic manifestations in 32%. Most frequent of these were hemorrhage postoperatively and following dental extraction. Purpura, epistaxis, hematemesis, hematuria, hemoptysis, menorrhagia, and subconjunctival hemorrhage were also seen. It is noteworthy that in these patients, as in the case presented, the bleeding time, Lee-White

clotting time, and prothrombin time are found to be within normal limits. It was only by carefully observing the character of the clot and the clot retraction that we were able to appreciate the abnormality present. Figure 1 shows the clot of a patient with polycythemia vera after 24 hours as compared with the normal. Figure 2 shows the same clot when poured from the test tube as compared with normal. It is seen that this clot has not retracted, is easily dispersed, and,

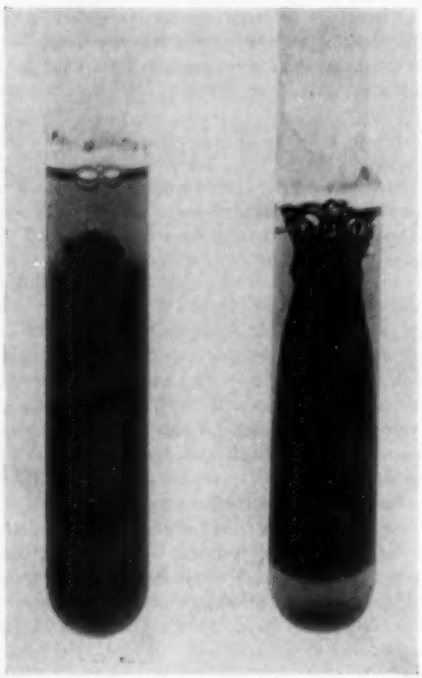

Fig. 1.—Test tube on left containing polycythemic blood shows poor clot retraction as compared with normal blood on right.

while it may be sufficient to give a normal end-point in the Lee-White determination, is hardly firm enough to effect good surgical hemostasis. It would seem, therefore, that a careful evaluation of the clot retraction is a more important preoperative test than the conventional bleeding time, clotting time, and prothrombin time in the polycythemic patient. Rosenthal [3] has described a method for measuring the clot retraction rate which should be of great value in studying the clotting mechanism in a specific patient. The test is based on the fact that red cells do not conduct electricity as well as serum. If two electrodes are submerged in a specimen of blood, there will be a curve of increasing resistance as the specimen clots and exudes serum. This curve can be recorded and will reflect the speed of clotting and degree of retraction. The curve produced by a normal blood differs characteristically from that produced by a polycythemic specimen.

The paradox of a disease causing both abnormal hemorrhage and thrombosis has been variously explained. The thrombotic manifestations are easily understood in view of the marked thrombocytosis and increased viscosity of the blood. The cause for bleeding tendency is less obvious. Most observers feel that it is probably due to the rapid but defective clot retraction. That the rate of retraction is increased in this disease has been shown by studies with the clotting rate measured electrically by Rosenthal. This rapid retraction does not permit incorporation of the bulk of red cells which are left suspended in the serum. The clot, composed predominantly of fibrin, can be easily dispersed. Bjorkman [4] describes three cases of polycythemia vera with bleeding tendencies which showed a fibrinopenia and states that the low fibrinogen levels are the main cause. He suggests that fibrinogen determination be used to predict whether thrombosis or hemorrhage will be the immediate danger. Dameshek [5] feels that the widely overdistended capillaries which are seen in polycythemia vera are responsible for the tendency to bleed. In our own case we noted hepatosplenomegaly and distended superficial abdominal varices. We believe that the increased venous pressure, often seen in this disease, may contribute greatly to the bleeding.

The abnormal clotting mechanism has been found to depend predominantly on the red cell mass and the number of circulating platelets. Before surgery an attempt should be made to return both these factors to normal values. P^{32} has been found to be the most effective method because of its central

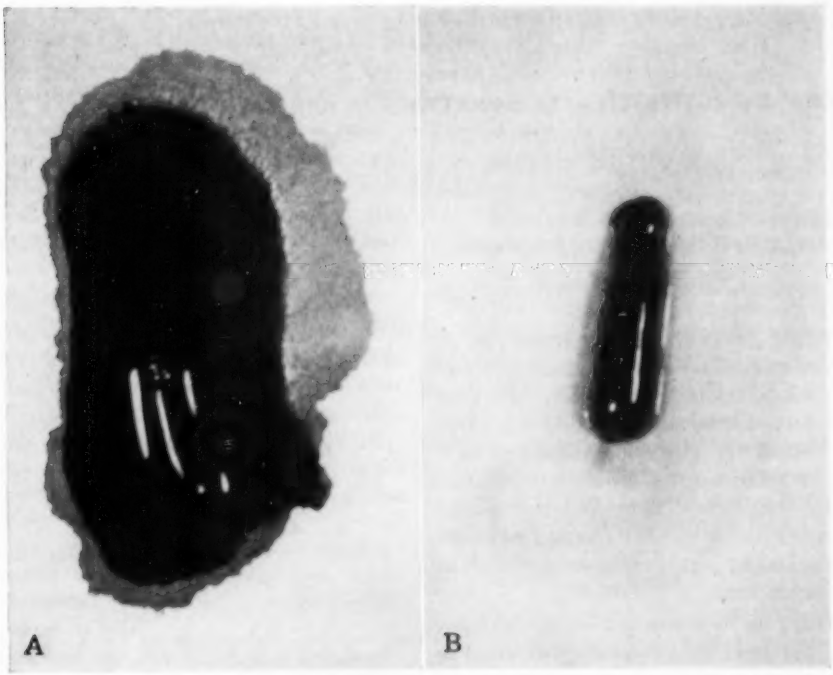

Fig. 2.—Demonstrates diffuse polycythemic clot (*A*) poured onto a blotter, and (*B*) as compared with well-retracted normal clot.

action. The older, and faster method of phlebotomy seems to stimulate thrombocytosis while correcting the erythrocythemia. In any case careful attention should be paid to the integrity of the retracted clot before surgery is undertaken.

SUMMARY

A case of polycythemia vera complicated by postoperative hemorrhage is presented. It is noted that in the surgical literature the thrombotic tendency is stressed. The potentially serious complication of hemorrhage is probably related to the excessive number of red cells and platelets and has been successfully managed by judicious phlebotomy. Preoperative treatment should include reducing the blood elements to normal values with P^{32}. Conventional blood studies, i. e., bleeding time, clotting time, and prothrombin time do not reflect the defect and must be supplemented by a careful study of the retracted clot.

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REVIEW OF POSTMORTEM EXAMINATIONS IN COMBAT CASUALTIES

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BECAUSE of the clinical responsibilities of medical officers in a combat theater, complete postmortem examinations have seldom been routine. Pathologists are rarely available at the surgical hospital, and facilities for postmortem study are often discouraging. Although it is obvious that combat casualties die of wounds received in action, a clear insight into the mechanisms of death is often lacking.

During a 10-month period in 1952 and 1953, autopsies were routinely performed by the Surgical Research Team in Korea at the 46th Surgical Hospital on the Eastern Korean Front. Deaths resulting from wounds received in combat, vehicular accidents, burns, medical illnesses, and self-inflicted injuries were investigated.

This report deals only with 35 patients who died in the hospital after being wounded in combat. Analyses of the other traumatic deaths have been deleted in an effort to emphasize the problems encountered in treating the combat casualty. Because of the relatively small number of autopsies presented, statistical significance cannot be ascertained; definite trends, however, can be observed and some generalizations made.

Most of the autopsies were performed by the same prosector. Clinical histories were recorded in great detail, and frequently the prosector had observed the clinical course of the patient prior to death. As a result, considerable consistency in examination and interpretation was possible. Microscopic review and interpretation were carried out by several members of the Pathology Department of the 406th Medical General Laboratory.

Table 1 summarizes the causes of death in 35 combat casualties. There is considerable overlap among the first three groups: irreversible shock, vital organ damage, and uncontrolled hemorrhage. Some patients with vital organ damage and others with uncontrolled hemorrhage showed changes consistent with those seen in irreversible shock.

TABLE 1.—*Causes of Death in Thirty-Five Combat Casualties*

Cause of Death	Patients, No.
Irreversible shock	11
Vital organ damage	9
Uncontrolled hemorrhage	6
Bronchial obstruction	2
Cardiac arrest	1
Myocardial infarction	1
Blast injury (lungs)	1
Fat embolism (cerebral)	1
Post-traumatic renal insufficiency *	1
Subdural hematoma	1
Cause undetermined	1
	35

* Most patients with this syndrome were selectively evacuated to the Renal Insufficiency Center; death, therefore, rarely occurred at the forward hospital.

On the other hand, a few classified as dying of irreversible shock exhibited uncontrolled hemorrhage during some period of their clinical course. Despite this overlap, the major cause of death, determined by considering all known factors, formed the basis of this classification. The causes of death in the remaining patients were quite specific.

Irreversible Shock: Every clinician and investigator attending six of these patients agreed that hemorrhage had been controlled; yet, after operation, the patients remained refractory to massive transfusions. These six patients died in a state of recurrent shock, unreversed by every known therapy.

From the Surgical Research Team in Korea, of the Army Medical Service Graduate School, and the Department of Pathology, of the 406th Medical General Laboratory, United States Army.

TABLE 2.—*Median Values, Evacuation Time, Survival Time, and Blood Volume Replacement in Eleven Patients with Irreversible Shock*

Evacuation Time: Wounding to Forward Surgical Hospital	Survival Time: Wounding to Death	Total Blood Volume Replacement
4 hr. 45 min.....	17.5 hr.	9.5 L.

An additional five patients after prolonged, profound shock, demonstrated a gradual response to transfusion but died shortly thereafter. The histologic picture in these two groups was similar. Although the clinical course of the latter five patients was not marked by as profound a terminal hypotension as that of the first group, the autopsy findings suggested that death was due to irreversible ischemic changes secondary to the initial shock.

Table 2 gives the median values for the evacuation time, survival time, and blood volume replacement in the 11 patients with irreversible shock.

Table 3 shows a tabulation of morphologic findings which were found in various combinations in irreversible shock. Petechial hemorrhages involving serous surfaces and mucous membranes were frequent and were believed to be the result of prolonged hypoxemia. Subendocardial hemorrhages were often seen, being peculiarly limited to the right side of the heart, a distribution also noted in patients who died of hemorrhagic fever. It may be that the differences in anatomy and physiology between the left and the right heart explain this peculiar localization of hemorrhages, but no positive evidence is available to date.

TABLE 3.—*Morphologic Changes in Irreversible Shock*

1. Petechial hemorrhages—serosal, mucosal (gastrointestinal)
2. Dilatation and engorgement—vessels in abdominal and thoracic viscera, brain, striated muscle
3. Pulmonary edema
4. Pulmonary atelectasis—focal and diffuse
5. Dilatation of cardiac chambers with flabbiness of the myocardium
6. Renal tubular changes consistent with post-traumatic renal insufficiency (microscopic)
7. Lipoid depletion—adrenal cortex cells (microscopic)
8. Fatty vacuolation—heart muscle, liver, kidney (microscopic)

Intense congestion of all organs and striated muscles was a consistent finding. From the cut surface of the lungs, liver, spleen, and kidneys, fluid blood virtually poured out.

Microscopic examination confirmed the severe dilatation and congestion of all blood vessels. The large quantity of blood transfused was presumably needed to maintain an adequate arterial pressure because of an expanded vascular tree.

Table 4 shows various degrees of pulmonary edema in the patients with irreversible shock. The majority demonstrated some degree of edema and over half exhibited marked edema. There appeared to be more edema in those patients who were most vigorously resuscitated. It must again be emphasized that these patients represent a very small sampling and that most patients requiring large transfusions survived.

TABLE 4.—*Degree of Pulmonary Edema Compared to Blood Volume Replacement in Patients with Irreversible Shock*

Degree of Pulmonary Edema	Patients, No.	Average Blood Volume Replacement, Liters
No edema (below 500 gm.)..	1	2.0
Slight (500 to 700 gm.).....	3	4.6
Moderate (700 to 900 gm.)..	1	12.0
Marked (900+ gm.).....	6	13.0

It has been suggested that pulmonary edema is a constant and integral part of the pathogenesis of shock.[1] Several factors may influence its development. The present study suggests that it follows shock and transfusion rather than ischemia alone. It is a frequent complication of post-traumatic renal insufficiency following shock. Cardiac failure, as evidenced by gross flabbiness of the myocardium, dilatation of cardiac chambers, and microscopic fatty degeneration of myocardial fibers must play a considerable role in the formation of pulmonary edema. In a review of a large number of traumatic deaths,[2] fat embolism was not found to predispose to this complication.

Varying amounts of pulmonary atelectasis were seen in several patients with irreversi-

ble shock. In some lungs, the areas of atelectasis were patchy, while in others the greater part of a single lobe was involved; this was usually basilar in distribution. These pulmonary findings may have represented agonal changes, as they are frequently seen in patients subjected to anesthesia and operation. In one of the 11 patients, diffuse atelectasis was thought to be one of the principal factors contributing to the fatality.

Congestion of striated muscle is listed as a morphologic finding in irreversible shock. This is particularly true of casualties strenuously resuscitated with whole blood and fluids. Striated muscle composes a large part of the human body but is not often studied at the necropsy table. A great part of the vascular tree, however, is found in these large masses of muscle. The typical finding in examining large avulsive wounds was severe congestion with outpouring of blood and fluids at autopsy incision. Further studies are necessary to correlate this observation with the theory of blood sludging and pooling.

Renal damage was a frequent finding in irreversible shock. The principal morphologic changes consisted of hemecasts within tubules and varying degrees of degeneration of the tubular epithelium. In a larger series of patients, these changes, when present, were found to be demonstrable after the first 24 hours of shock.[8] In the present study, each patient demonstrated clinically a decrease in renal function, but this might have been on a functional rather than on an organic basis. Four of the 11 patients showed morphologic changes consistent with post-traumatic renal insufficiency. The remaining patients might have exhibited these changes had the time of survival been longer than the mean of 17.5 hours.

Mallory,[8] in studying postmortem material from shocked patients during World War II, found a peculiar morphologic change in the viscera when the survival time was over 18 hours. With special stains, fat vacuolation was demonstrated in the heart, the central cells of hepatic lobules, and the ascending limbs of Henle's loops. In the adrenal gland the doubly refractile lipid became depleted after the same time interval. From the fourth day onward, in patients with wounds not complicated by infection, a tendency to a return to normal could be demonstrated. Special stains were not performed in patients presented in this report. However, Mallory's finding is another morphologic demonstration of an intracellular response to injury and shock.

TABLE 5.—*Patients with Uncontrolled Hemorrhage*

Patient No.	Evacuation Time: Wounding to Hospital, Hours	Total Blood Volume Replacement, Liters	Pulmonary Edema	Site of Bleeding	Survival Time After Injury, Hours
1	5.5	10.5	None	Laceration of pulmonary vessels	11.8
2	3	0	None	Splenic rupture; laceration of lung	3
3	2.5	Total unknown 3.5	None	Lacerated kidney; retroperitoneal hemorrhage	18
4	4	18	None	Lacerated vena cava	17
5	1	6.5	Moderate	Lacerated dural vessels	4.5
6	1.5	9.5	Moderate	Lacerated mesenteric vessels, multiple	3.5

Vital Organ Damage: Nine patients died of damage to vital organs to a degree incompatible with life. Seven showed extensive brain damage and two direct cardiac involvement by shell fragments. The majority of these patients survived for several hours.

Uncontrolled Hemorrhage: Table 5 gives information concerning six patients whose deaths were attributed to uncontrolled hemorrhage. All showed profuse bleeding from lacerated, large vascular channels. It appeared in most instances that if early con-

trol of profuse hemorrhage had been possible, death might have been prevented. The average evacuation time from wounding to hospital admission was considerably shorter than that seen in irreversible shock. Pulmonary edema was a less frequent finding.

Bronchial Obstruction: Two patients in this series died of bronchial obstruction. One patient had a simple amputation of a lower extremity which was technically uncomplicated. He died 15 minutes postoperatively, owing to aspiration of vomitus. The second patient suffered a perforating wound of the lung with bleeding into the bronchial tree. Obstruction and death occurred shortly after hospital admission.

Cardiac Arrest: One patient with multiple avulsive and perforating wounds of all extremities died unexpectedly during surgery. Cardiac massage was performed without benefit. A moderate number of fat emboli were visible microscopically in small myocardial blood vessels. It is not known what influence they may have had on cardiac function.

Myocardial Infarction (Traumatic Coronary Thrombosis): Myocardial infarction resulting from coronary thrombosis was a surprising finding in one patient. After a wound of the left lung from small arms fire, this patient developed progressive cardiac failure during surgery. At autopsy, an antemortem thrombus was found in the lumen of the circumflex branch of the left coronary artery. Histologically the myocardium exhibited degenerative changes. Although there was no myocardial laceration in the region of the left coronary artery, diffuse subepicardial and perivascular hemorrhages suggested that contusion and arteritis may have occurred from the marked pressure changes when the missile passed through the thorax.

Fat Embolism: Fat embolism has been recognized for many years as a complication of trauma and fractures. Different investigators have ascribed varying degrees of importance to it as a clinical entity. Scully [2] showed that fat emboli were present in the lungs in more than 90% of men dying of battle wounds. Occasionally emboli were found in the kidneys. Death resulting from fat embolism was infrequent in his review. The criteria for establishing fat embolism as a cause of death are a typical clinical history, abnormal neurologic findings, and the presence of a moderate to a marked degree of fat in the vessels of the lung, kidney, and brain. Perivascular hemorrhages and necrosis in the brain are the usual findings in fatal instances.

The one fatality due to fat embolism in this series was classic. The patient suffered traumatic amputations of several extremities and numerous avulsive and puncture wounds. Preoperative resuscitation and surgery were uneventful. Recovery, however, from anesthesia was not complete and intracranial hemorrhage was suspected, as the patient remained unconscious and displayed muscular twitchings. A craniotomy showed no evidence of hemorrhage. Death ensued several days after injury. Postmortem examination revealed the typical morphologic findings of fatal fat embolism.

Blast Injury: In World Wars I and II injuries to the thoracic and abdominal viscera and to the central nervous system were observed to result from rapid changes in the environmental pressure such as from an air blast.[4] When persons are exposed to the effects of nearby shell and mortar explosions, death may occur with minimal evidence of external injury. Hemorrhages and lacerations of the lungs, abdominal viscera, or brain may occur. One patient in this series was close to an exploding mortar round and died shortly afterward in severe respiratory distress with hypoxia. At autopsy he had severe pulmonary hemorrhage, congestion, contusion, and edema without perforation of the thorax. A large shell fragment was found in the region of the left kidney.

Post-Traumatic Renal Insufficiency: One patient with marked renal insufficiency resulting from multiple perforations of the small intestine was included in this series. The patient died in uremia six days after wounding. The morphologic findings were compatible with severe lower nephron ne-

phrosis. There were numerous hemecasts in renal tubules and marked degeneration of the tubular epithelium. A fibrinopurulent peritonitis was also present.

Subdural Hematoma: In one instance, a subdural hematoma resulted as a complication of a skull fracture. A large subdural blood clot was evacuated. Death followed shortly thereafter, due to recurrent intracranial pressure.

Cause Undetermined: The one patient for whom a cause of death could not be established suffered a gunshot wound of the abdomen with a laceration of the tail of the pancreas. His postoperative course seemed uneventful and he was ambulated early. On the sixth postoperative day he suddenly, developed severe respiratory distress and died 12 hours later in vascular collapse. The clinical history was suggestive of pulmonary embolism, but the autopsy did not confirm the diagnosis. There were no significant findings to demonstrate the cause of death.

SUMMARY

An analysis of 35 postmortem examinations in combat casualties dying relatively soon after wounding is presented. Irreversible shock, vital organ damage, and uncontrolled hemorrhage constituted the major causes of death. Bronchial obstruction, cardiac arrest, traumatic coronary thrombosis, blast injury, and subdural hematoma were found less frequently. Although fat embolism was frequently found in the lungs after traumatic death, it appeared to be the principal factor causing death in only one patient. Post-traumatic renal insufficiency was the cause of death in only one patient in this series, as the group of patients with this complication were selectively evacuated to another hospital.

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PRIMARY BRONCHOGENIC CARCINOMA OF LUNG

Statistical Study of Seven Hundred Four Private Patients

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THE INCREASING urgency of the problem of primary bronchogenic carcinoma of the lung is attested to by Cameron's 1953 annual report to the American Cancer Society, which indicates that at the present time lung cancer is very close to, if not the leading cause of, death from cancer, and that, at least as an officially listed cause of death in vital statistics, it is increasing at an alarming rate (Table 1). How much of this increase is real and how much is due to more accurate diagnosis is a matter chiefly of academic interest. From a practical point of view, the important thing is that the diagnosis and treatment of cancer of the lung is today a real problem in the practice of medicine. For 10 years there have been in the literature more and more papers on this subject, and one of the chief burdens of these papers has been the large proportion of patients with carcinoma of the lung which has not been diagnosed until it has progressed beyond the limits of effective treatment. One would expect that such continued medical publicity would bring about some improvement in this unhappy situation. It has been our impression that no such improvement was taking place, and a survey of our surgical experience over the past 11 years bears out the correctness of this impression (Table 2).

Read before the Section on Surgery, General and Abdominal at the 103rd Annual Meeting of the American Medical Association, San Francisco, June 23, 1954.

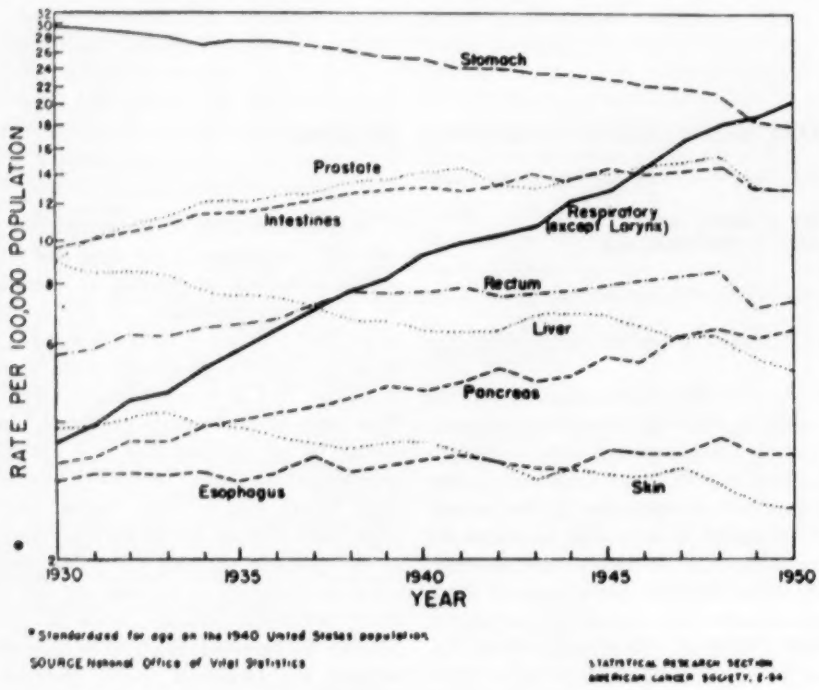
In 1943 some 20% of the patients we studied with carcinoma of the lung had lesions which permitted an attempt at extirpation by pulmonary resection. In the following years that proportion varied somewhat, but again in 1953 the percentage is the same as in 1943. This is a lower resectability rate than some others recently published,* but it should be remembered that it is difficult to compare these rates without knowing to what extent and in what manner patients have been selected before they are referred to the thoracic surgeon. In public institutions the tendency is to weed out the obviously inoperable patients, while in private practice the reverse is likely to be true, either because the physician wants someone to share the responsibility of denying surgery to his patient or because the patient insists upon the consultation.

We share the concern of other thoracic surgeons † over the long delay between the onset of symptoms and the clinical diagnosis of carcinoma of the lung. Any lessening in that delay through increasing awareness in the minds of physicians of the diagnostic possibility of pulmonary neoplasm appears to us to have been more than offset by the use of an ever-increasing array of antibacterial drugs. The symptoms and often the x-ray evidence of improvement in pulmonary lesions brought about by the use of these drugs has, we believe, tended to increase considerably the delay in reaching a diagnosis. In conversations with many physicians we have become aware of other factors of importance in causing this delay. One of them is the great reluctance which many physicians have for entertaining a diagnosis of cancer of the

* References 3 and 7.

† References 1, 5, 6, 7, 8, and 9

TABLE 1.—*White Male Cancer Death Rates* by Site, United States, 1930-1950*



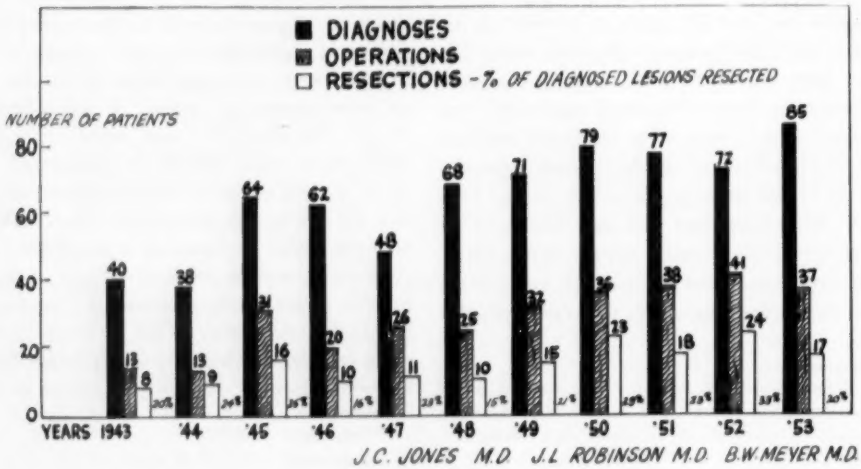
*Standardized for age on the 1940 United States population.

SOURCE: National Office of Vital Statistics

STATISTICAL RESEARCH SECTION
AMERICAN CANCER SOCIETY, 5-54

lung because of the belief that such a diagnosis is virtually a death sentence for the patient. Another factor is the belief that a diagnostic thoracotomy is an operation fraught with considerable hazard. In order to gain some information which might help in dispelling these beliefs and perhaps indicate ways in which the low salvage rate for

TABLE 2.—*Number of Diagnoses, Operations, and Pulmonary Resections*



patients with carcinoma of the lung might be improved, we have undertaken a study of the private patients with carcinoma of the lung whom we have seen over the past 11 years. We decided to limit the study to private patients because the diagnostic and surgical factors controlling their fate had been more uniform than for patients in public institutions. The diagnostic and surgical techniques we employed were presented in an earlier paper [5] by one of us (J. C. J.) and are not discussed in this paper.

In the 11-year period from 1943 through 1953 (a few patients seen in 1942 have been included with the 1943 patients), we have seen a total of 704 private patients for whom we have made or have accepted a diagnosis of primary bronchogenic carcinoma of the lung. Not all these patients have had a histological diagnosis, but in those in whom the diagnosis was not so confirmed the clinical evidence has been so overwhelming as to leave little doubt as to its correctness. These patients have been referred to us by our medical colleagues in the vicinity for the purpose of diagnostic consultation and such surgical treatment as could be offered them. It has been our policy to return the patient to the

TABLE 3.—*Sex Ratio*

YEARS	DIAGNOSES	MALES	FEMALE	% FEMALE
1942 THROUGH 1949	391	343	48	12.3
1950 THROUGH 1953	313	269	44	14.0
TOTAL	704	612	92	13.0

TABLE 4.—*Age Distribution*

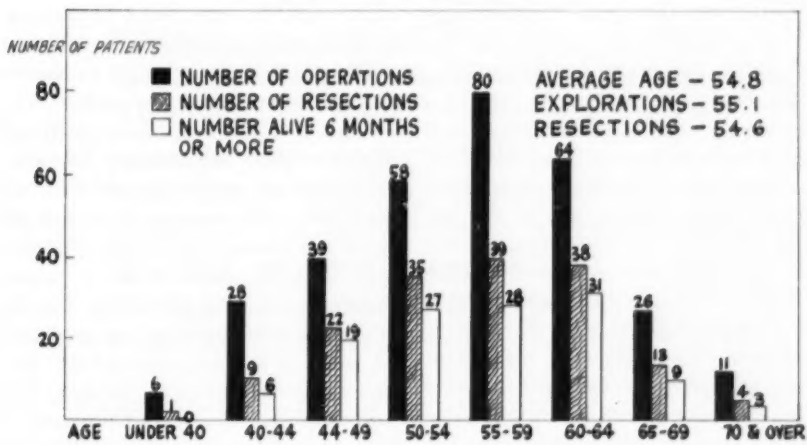


TABLE 5.—*Comparison of Patients Under and Patients Over 50*

AGE	RESECTABILITY		5 YEAR SURVIVAL	
	OPERATED	RESECTED	RESECTED	5 YR. SURVIVAL
UNDER 50	73	32 – 44%	17	6 – 35.3%
OVER 50	239	129 – 54%	47	9 – 19.2%

care of his referring physician as soon as he has recovered from surgery or we have reached an opinion that surgery is not indicated. This practice has made the gathering of statistics concerning the fate of our patients more difficult than in the case of clinic or public hospital practice.

AGE AND SEX DISTRIBUTION

The sex distribution in our patients has been about the same as that reported in the literature, namely, 87% males, or about eight males to one female (Table 3). The past four years have seen a slight, but probably not statistically significant, rise in the proportion of females—from 12.3% for the period 1943 through 1949 to 14% from 1950 through 1953.

The average age of 312 patients operated upon was 54.8 years, with little difference between the average age of those who had pulmonary resections and those in whom merely exploratory operation was done (Table 4). More patients fell in the age group of 55 to 59 than any other, but the highest resectability rate was in the 60 to 64-year olds. However, our previously held opinion that patients less than 50 years of age with carcinoma of the lung had a comparatively poor prognosis has not been borne out (Table 5). It is true that the resectability rate was lower (44% of those operated on, as compared with 54% in the patients more than 50), but if the lesion could be surgically attacked their chances for a five-year survival were much better.

SELECTION OF PATIENTS FOR OPERATION

In order to give meaning to our operability and resectability rates, it is necessary to indicate our criteria for declining to recommend surgery, as well as our practice concerning so-called "palliative resection." The presence of any one or more of the following conditions, in most cases has caused us to consider a patient unsuitable for surgery: (1) evidence of distant metastases; (2) evidence of extension of the new growth into the mediastinum, pleura, chest wall, or other adjacent structures; (3) bronchoscopic evidence of new growth at or above the level of the carina or in the contralateral bronchus; (4) evidence of other disease, either organic or functional, which makes the patient's survival of surgery unlikely. These are criteria which are quite generally accepted, although the interpretation of evidence bearing on them varies in different clinics. Probably only as regards paralysis of the vocal cord or diaphragm is there any great difference of opinion in various groups. We consider the presence of either of these conditions to be sufficient evidence, when accompanied by corroborating bronchoscopic or roentgenological findings, to contraindicate surgical exploration. We are aware of the fact that in some cases pneumonectomy will be technically feasible under these circumstances, but we do not believe the patient's chances for survival are sufficiently increased to justify surgical intervention. Likewise, we do not believe palliative pneumonectomy in the presence of extension of the new growth beyond the limits of extirpation is often justified. Only in cases of severe pulmonary suppuration and/or pulmonary bleeding or in cases in which surgery has progressed too far before it becomes apparent that the disease has extended beyond the lung have we performed pulmonary resection and knowingly left behind part of the neoplastic lesion

EXTENT OF RESECTION

In only 29 of the 312 patients having resection was the amount of resection less than one lung. No lobectomies were done prior to 1946, and most of the 29 have been done since the Los Angeles County-wide chest x-ray survey of 1950. That survey, as did many others throughout the country, brought to light some so-called "silent" lesions. The problem of how many of these solitary, circumscribed lesions in the lung are cancer and of how to treat them has called forth a number of papers, that of Bernatz and Clagett, of the Mayo Clinic, containing the largest series that we have seen.[3] Actually, we have performed lobectomies in two types

of patients: first, those of the type just mentioned, in whom diagnosis has not been established prior to surgery, and second, those whose pulmonary function is so low as to make pneumonectomy unwise. In the former group, it has been our policy to ask the pathologist to give us an immediate diagnosis based upon examination of the lesion in the resected lung tissue. In the case of carcinoma of the lung, if the lesion is well peripheral and is located well away from the fissures and if there is no demonstrable evidence of metastasis to the lymph nodes, we are satisfied to limit the surgery to a lobectomy. With regard to the second group of patients, we have found it helpful to make pulmonary function studies for all patients who show clinical evidence of considerable loss of pulmonary reserve. If such studies indicate that the patient has sufficient pulmonary function to withstand the loss of one lobe but will become a pulmonary cripple after pneumonectomy and if the lesion appears roentgenologically to be amenable to lobectomy, we accept him for surgical exploration.

TABLE 6.—*Early Results*

NUMBER DIAGNOSED	704	% OF DIAGNOSED
NUMBER OFFERED SURGERY	346	49.0
NUMBER OPERATED UPON	312	44.0
NUMBER OF PULMONARY RESECTIONS	161	23.0

OPERATIVE MORTALITY

NUMBER OF OPERATIONS ——— 312
NUMBER OF HOSPITAL DEATHS ——— 8
MORTALITY RATE ——— 2.6%

NUMBER OF RESECTIONS ——— 161
NUMBER OF HOSPITAL DEATHS ——— 7
MORTALITY RATE ——— 4.3%

NUMBER OF EXPLORATIONS ——— 151
NUMBER OF HOSPITAL DEATHS ——— 1
MORTALITY RATE ——— 0.7%

TABLE 7.—*Period of Survival Following Pulmonary Resection for Carcinoma*

	OCHSNER ET. AL.			GIBBON ET. AL.			JONES ET. AL.		
	OBSERVED	ALIVE	%	OBSERVED	ALIVE	%	OBSERVED	ALIVE	%
ALIVE 6 MOS. P.O.	298	149	50.	185	115	62.	161	119	74.
ALIVE AT 1 YR.	267	85	32.	175	84	48.	144	67	46.
ALIVE AT 2 YRS.	221	44	20.	145	46	32.	120	39	32.
ALIVE AT 3 YRS.	179	31	17.	111	36	32.	102	29	28.
ALIVE AT 4 YRS.	130	27	21.	77	20	26.	79	19	24.
ALIVE AT 5 YRS.	99	19	19.	41	9	22.	64	15	23

EARLY RESULTS

Of our 704 patients with a diagnosis of carcinoma of the lung, we recommended surgical exploration in 346, or 49% (Table 6). Of this number 312, or 44% of the total accepted this recommendation and underwent exploratory operation. Eight patients died as a result of surgery, an operative mortality rate of 2.6%. Of the 312 operations, surgical resection of part or all of the lung was accomplished in 161, 51.6% of the operations performed and 23% of the number of cases in which diagnosis was made. The operative mortality for those having resection was

TABLE 8.—*Survival Curve for 644 Patients Having Pulmonary Resection for Carcinoma (From Ochsner, Gibbon, and Jones Groups)*

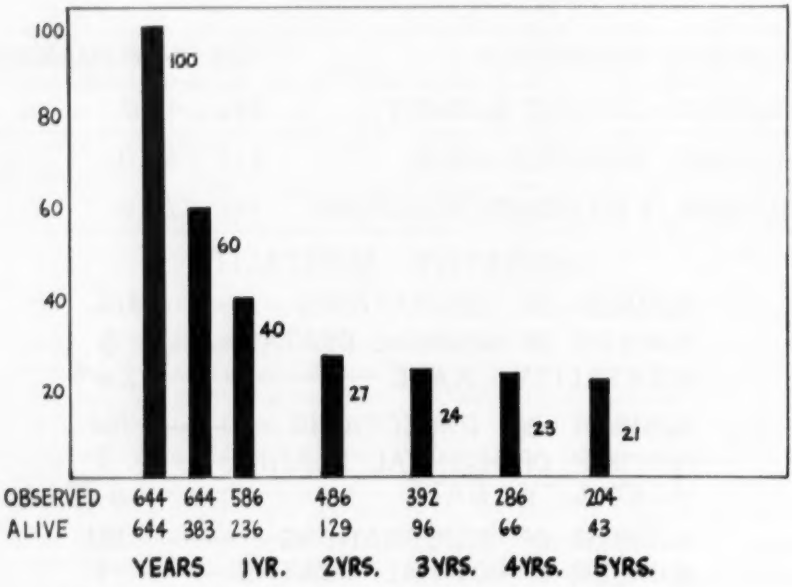


TABLE 9.—*Five to Eleven Year Follow-Up Study of 320 Patients*

NUMBER DIAGNOSED					320
NUMBER OPERATED UPON				128	40.0%
NUMBER RESECTED			64	50.0%	20.0%
NUMBER ALIVE OR DEAD FROM NON-CANCER CAUSES		20	31.2%	15.6%	6.3%
NUMBER OF 5 YEAR SURVIVALS	15		23.4%	11.7%	4.7%
NUMBER ALIVE TODAY	12		18.7%	9.4%	3.8%

FATE OF 39 PATIENTS EXPLORED
DEAD WITHIN 6 MONTHS OF OPERATION — 31 OR 74%
DEAD WITHIN 1 YEAR OF OPERATION — 37 OR 95%
DEAD WITHIN 2 YEARS OF OPERATION — ALL

4.3%. In 131 patients no resection was attempted, and of these, only 1, or 0.7%, died as a result of the surgical procedure.

LATE RESULTS

Unfortunately, about two-thirds of the patients undergoing pulmonary resection in an attempt to extirpate the neoplasms had had extension of the lesion by lymph or blood stream channels before they came to surgery, and, as a result, eventually died of those extensions (Table 7). Of 161 patients observed for six months, 74% were alive at the end of that period; 46% of the 144 were alive at the end of one year; 32% of the 120 were alive at the end of two years; 28% of 102 were alive at the end of three, 24% of 79 were alive at the end of four, and 23% of 64 were alive at the end of five years. This experience agrees fairly well with that of the Ochsner [5] and Gibbon [4] groups, and the combined experience is graphically shown in Table 8. Sixty percent of 644 patients were alive at the end of six months, 40% of 586 at the end of one year, 27% of 486 at the end of two years, 24% of 392 at the end of three years, 23% of 286 at the end of four years, and 21% of 204 at the end of five years.

But not all patients who die after successful pulmonary resection for carcinoma of the lung die of carcinoma, and when we fail to take this fact into consideration in speaking of our surgical "salvage rates" we are doing surgery an injustice. It must be remembered that the average age of our surgical patients was 54.8 years, and the expected death rate in the normal population of this age is rather high. In order to gain more information concerning our actual "salvage rates," we have studied the fate of 64 patients who had pulmonary resection for cancer between the years 1943 and 1948, inclusive, and who have thus been followed for periods varying from 5 to 11 years. During this time, we saw 390 patients with primary bronchogenic carcinoma of the lung (Table 9) and recommended surgery in 128, or 40%. Exactly one-half of these patients had a successful pulmonary resection, and the other half underwent only exploratory operation. Of the 64 patients in whom exploratory operation was done, we were able to follow 39. Of these, 31, or 74%, were dead within six months; 37, or 95% were dead within one year, and all were dead within two years. The 64 patients having successful pulmonary resections had an average age of 54 years, and those who survived surgery were followed for an average of eight years. Four patients died as a result of surgery, and 40 patients died as a result of metastatic carcinoma. Eight patients died of causes other than carcinoma, and 12 patients are living and well at present. Standard mortality tables used by insurance companies predict that in the white male population followed for eight years 9 out of 60 in this age group will die, and the average life expectancy is only 18 years. So our experience of eight patients dying from causes other than carcinoma is not out of line. All eight of these patients survived surgery for at least two and one-third years, in fact, any patient dying less than two years postoperatively was considered to have died of carcinoma, regardless of the cause of death listed in the death certificate. So our corrected survival rate in this group of patients is 31.2% of those having pulmonary resection, 15.6% of those in whom exploratory operation was done, and 6.3% of those in whom the diagnosis of pulmonary carcinoma was made.

It is of interest to note that one patient had a fatal recurrence of his carcinoma more than nine years after surgery, emphasizing the fact that a five-year survival goal is not a magic point, the attainment of which protects a patient from any possible appearance of any metastatic lesion. As previously shown in graph form, deaths from metastatic carcinoma after pulmonary resection occur at an exponential or algebraic, rate. In the case of the 60 patients followed, this rate was about 50% per year of those alive at the beginning of each year. In Table 10, we have compared the predicted deaths based upon this formula with those actually occurring from carcinoma, as well as with the deaths occurring from all causes. Thus 20 patients

now living or dead from causes other than carcinoma subtracted from 60 patients leaving the hospital alive leaves 40 patients dead of carcinoma. According to our formula, 20 should die the first year, 10 the second, 5 the third, 2½ the fourth, and 1¼ the fifth year postoperatively. Actually, our figures were 23 the first year, 10 the second year, 3 the third year, 2 the fourth year, and 1 the fifth year, which is in fairly close agreement. We do not mean to imply that such an exact formula derived from such a small number

TABLE 10.—*Follow-Up Study of 64 Patients 5 to 11 Years After Pulmonary Resection*

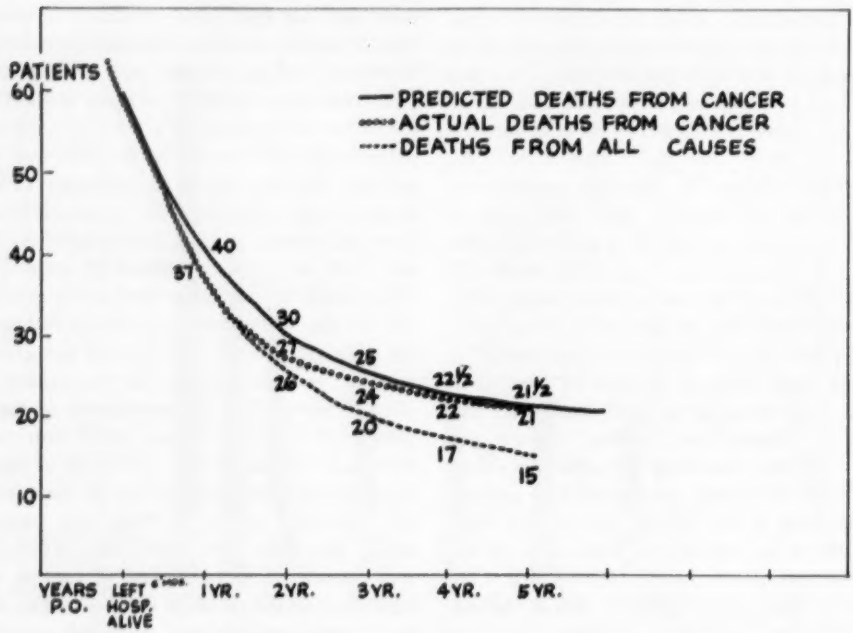


TABLE 11.—*Comparison of Pneumonectomy and Lobectomy Experience*

	PNEUMONECTOMIES		LOBECTOMIES	
YEAR	NUMBER	% OF RESECTIONS	NUMBER	% OF RESECTIONS
PRIOR TO 1949	63	98.4	1	1.6
1949	13	86.7	2	13.3
1950	16	69.6	7	30.4
1951	13	72.2	5	27.8
1952	18	75.0	6	25.0
1953	9	53.0	8	47.0
TOTAL	132	82.0	29	18.0

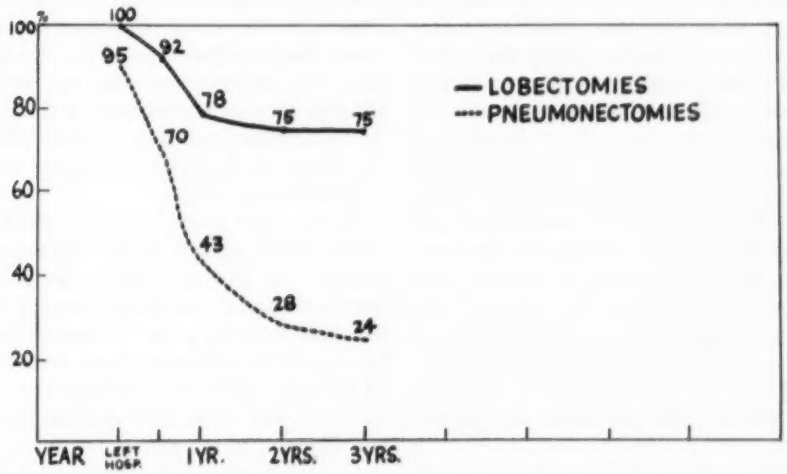
MORTALITY

	NUMBER OF OPERATIONS	OPERATIVE MORTALITY	ALIVE TODAY
PNEUMONECTOMY	132	7 - 5.3%	22 - 16.7%
LOBECTOMY	29	0 - 0.	20 - 69.0%

of individuals can be universally applied, but the observed results are in general agreement with other published survival rates and indicate that about one-half of the patients whose neoplastic disease was not entirely extirpated at the time of surgery will die in the first postoperative year, and about 90% will be dead within three years.

Further study of the 20 patients who are either still alive or who died of causes other than carcinoma was made in an attempt to throw some light upon the reasons for their survival. Of greatest significance is the fact that of the 20, only 6 had microscopic evidence of peribronchial lymph node involvement in the resected specimen, and only 1 had involvement of the mediastinal nodes. The point of origin in the bronchial tree is of further significance. In only 1 of those surviving was the carcinoma in the main bronchus; in 4 it was in a lobar bronchus, and in 15 in segmental or smaller bronchi. Thus it is seen that the survivals have been largely among the patients who had peripheral lesions which were brought to surgery before they had spread by way of the blood stream or had metastasized to mediastinal lymph nodes. Further support for this thesis is given by a study of the survival rates of a small group of patients in whom the neoplasm was treated by resection of only one lobe under the conditions previously laid down (Table 11). In the 29 lobectomies, there were no operative deaths, and 20 patients, or 69%, are still alive. There were three palliative resections on patients in whom the extent of the lesions was not discovered until it was too late to turn back. Among the 20 living are 3 who are known to have metastasis. If we eliminate the three palliative resections and consider the three patients with metastases as already dead, we can make a three-year survival chart to compare with that of the patients having pneumonectomies (Table 12). It is seen that the lobectomy survival curve has flattened out at about 75% survival at the end of three years, whereas the pneumonectomy rate stands at 24%. This is admittedly too few patients to yield statistically important findings, and we do not wish to give the impression that we consider lobectomy a better operation than pneumonectomy or even a substitute for it in treating carcinoma of the lung. But it does encourage the belief that patients who have lesions of the type which, under the conservative criteria we have used in their selection, make them candidates for lobectomy have the best chance for survival after surgery.

TABLE 12.—*Three-Year Survival of Patients Treated by Lobectomy Compared with Those Treated by Pneumonectomy*



COMMENT

Clinical diagnosis of carcinoma of the lung should be more easily arrived at than clinical diagnoses of most other internal cancers, yet there continues to be a long delay between the onset of symptoms and the time the patient is presented to the thoracic surgeon for treatment. At present, the greatest hope for improvement in surgical treatment of lung cancer appears to lie in the greater use of the chest x-ray to bring to light the peripheral, relatively asymptomatic lesion. Because there is no cough reflex in the segmental bronchi, such lesions formerly were likely to be undetected until metastasis or extrapulmonary extension had occurred and therefore formed a rather small percentage of lesions seen in resected specimens. However the increasing use of the x-ray as a survey or periodic physical examination tool is permitting the diagnosis or detection of more and more peripheral lesions at a time when they are susceptible to surgical attack, and the improved survival rates in such patients gives hope for considerable improvement in the salvage rates for patients with carcinoma of the lung in the future. Those who are engaged in the general practice of medicine must be depended upon to bring to light these early lesions, and to them we would like to make the following suggestions:

1. Keep in mind the increasing incidence of carcinoma of the lung, and look for it in all male patients over 40.

2. Make a careful search for respiratory system symptoms a routine part of history-taking in all patients, regardless of their chief complaints.

3. Make the use of the chest x-ray a routine procedure in physical examination of all patients.

4. Cooperate with your radiologist in developing an economical technique for obtaining screening chest x-rays in your practice and encourage your adult male patients to have such x-ray examinations twice a year.

5. Consider all abnormal and not easily explainable x-ray shadows in adult male patients as possibly neoplastic in origin.

6. If pulmonary infiltrates do not completely disappear in a reasonably short period of antibacterial drug therapy, consider them as probably neoplastic.

7. Do not hesitate to recommend exploratory thoracotomy if a definite diagnosis is not reached after careful effort. It is a relatively safe surgical procedure with a mortality rate in our hands of only 0.7%.

SUMMARY AND CONCLUSIONS

Our surgical experience with 704 private patients with primary bronchogenic carcinoma of the lung over the past 11 years (1943 through 1953) has failed to demonstrate any real improvement in resectability rates, which remain in the vicinity of 20% of patients in whom diagnosis has been made. We believe that any improvement that has occurred through increased awareness of the disease as a diagnostic possibility has been offset by the delays in diagnosis incident to the use of antibacterial drugs.

During the 11-year period, in about two-thirds of 312 patients having pulmonary resection in an attempt to extirpate the lesion, the disease had already spread through lymph or blood channels prior to surgery, and so these patients eventually died of carcinoma of the lung. The deaths occurred at a rate of about 50% each year of those living at the beginning of the year.

Of 64 patients having pulmonary resection previous to 1949 and observed for from 5 to 11 years, 60 survived surgery, 40 died of metastatic carcinoma, 8 died of other causes, and 12 are still living and well 5 to 10 years after surgery. This represents a salvage rate of 31.2% of those patients having a successful operation and should help dispel the belief that carcinoma of the lung is necessarily a fatal disease.

When compared with the total number of patients seen with a diagnosis of carcinoma the salvage rate is only 6.3%. Any further improvement in surgical salvage rates must depend chiefly upon getting a higher proportion of patients to surgery before the neoplasm has extended beyond the lung. Suggestions towards this end are given.

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SURGICAL TREATMENT OF DIVERTICULITIS OF COLON

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WHEN A careful search is made, about one-third of people past 45 years of age will be found to have some diverticula of the colon. These lesions are found most commonly in the sigmoid, next in frequency in the descending colon, but may be scattered throughout the large bowel. We have never seen them below the peritoneal reflection.

It is our feeling that these are pulsion diverticula. Figure 1 is a section of the sigmoid done post mortem in an 80-year-old patient who had no symptoms referable to the colon. The only barrier between the lumen of the bowel and the peritoneal cavity is the mucosa, some subperitoneal fat, and the peritoneum. In this section we also see that in one area the mucosa is beginning to herniate through the muscularis as if a new diverticulum is forming near the main one. However, even the completely formed diverticula are still too small to be seen on casual examination. We have microscopic sections showing minute abscesses in the fat, with perforation of similar small diverticula.

The influence of increased intraluminal pressure on the formation of diverticula can be seen with obstruction due to carcinoma of the sigmoid. In such cases the diverticula nearest the obstructing tumor are deep, with induration and inflammation of the fat in the appendices epiploicae surrounding them. As the distance between diverticula and obstructing tumor increases, the diverticula become shallower and the inflammation in them is less marked.

From the Presbyterian Hospital.

Read before the Section on Surgery, General and Abdominal, at the 103rd Annual Meeting of the American Medical Association, San Francisco, June 24, 1954.

We commonly see cases in which carcinoma of the sigmoid is fixed to other structures and in which the fixation is due not to tumor but to inflammation arising in the accompanying diverticula. In such a patient who had a carcinoma of the sigmoid with firm fixation to the dome of the urinary bladder, the specimen of resected sigmoid, including the full thickness of the urinary bladder, showed three minute diverticula in line just proximal to the tumor. The fixation was due to an abscess in a diverticulum just proximal to the tumor and in line with the three diverticula, which were not inflamed. We believe that the associated inflammation is often responsible for the fixation in carcinoma of the sigmoid and consequently that the prognosis for fixed tumors in such instances is better than one might anticipate.

The narrow neck of the diverticulum with the contained inspissated feces points out the logic of the usual medical management, which is to be certain the patient does not become constipated. This can be accomplished by a dietary program which omits hard-shelled foods, seeds, or nuts and by the liberal administration of hygroscopic agents, such as psyllium hydrophilic mucilloid with dextrose (Metamucil). If these fecaliths become trapped, they act as foreign bodies and serve as centers of abscess formation, with frequent flare-ups under slight provocation, such as mild gastroenteritis, constipation, or upper respiratory infection. At such times we often recommend succinylsulfathiazole (Sulfasuxidine) prophylactically. When medical management fails, the indications for surgical intervention are (*a*) free perforation, (*b*) frank abscess formation, (*c*) partial or complete obstruction, (*d*) fistula formation, (*e*) the inability to exclude carcinoma, and (*f*) recurrent disability and pain.

In our experience, sudden free perforation has almost always occurred in a rather movable sigmoid after the giving of an enema

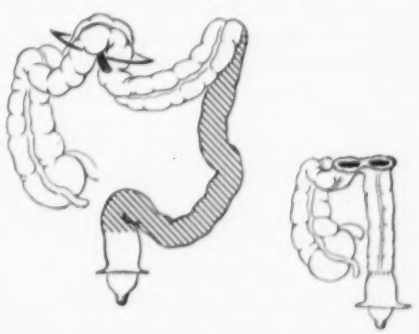
Fig. 1.—Sigmoid diverticulum lined only by mucosa, some subperitoneal fat, and peritoneum. The fecalith cannot escape through the narrow neck and thus acts as a foreign body, causing abscess formation. On the extreme right, the mucosa is beginning to herniate through the muscularis to form another diverticulum.

or when there has been a small abscess formed about a diverticulum. This abscess suddenly ruptures, and free pus and large flecks of pyrogenic membrane, along with some free gas and liquid feces, are found in the pelvis. Had the sigmoid been fixed, the abscess would probably not have perforated in this fashion. In most of these cases, it has been possible to exteriorize the sigmoid containing the perforation as in an obstructive resection. For increased mobility it may be necessary to split the peritoneum along the lateral edge of the sigmoid. After the abdomen is closed, the area of perforation is enlarged to serve as a colostomy opening. After the patient has recovered from peritonitis, the exteriorized bowel is amputated almost flush with the level of the abdomen, and at a later date the colostomy is closed as in the usual obstructive resection. This has given satisfactory results in every instance. If the diverticulum perforates in a portion of bowel which cannot be easily mobilized, the perforation should be closed with absorbable surgical (gut) sutures and covered with omentum, and Penrose drains should be placed near the site of perforation and brought out through a stab wound. A right transverse colon double-barrel colostomy should also be performed.

When diverticulitis in the sigmoid leads to abscess formation, it usually points slowly, either just above the medial portion of Poupart's ligament or in the flank just above and lateral to the anterior superior iliac spine. These abscesses are slow to form, and drainage should not be instituted too early. They can usually be drained extraperitoneally through incisions above Poupart's ligament or in the left flank. In women who have had a hysterectomy, an abscess will occasionally occur between the sigmoid, rectum, bladder, and vagina. These point in the vagina and can be drained through a posterior colpotomy. In performing this procedure, a No. 15 needle can be used to localize the abscess, while a palpating finger in the rectum guards against making a false passage into the rectum. At the same time, a right transverse colostomy should be made. Most of these patients with abscesses will have repeated difficulty until the involved bowel is resected.

Partial or complete obstruction may occur in those who have had repeated bouts of diverticulitis of the sigmoid. Most patients have many diverticula in the descending colon as well as in the sigmoid. It is our feeling that the descending colon should also be removed if it contains diverticula (Fig. 2). We feel this is the extent of resection indicated in the great majority of cases. This procedure not only removes most of the involved colon but also leads to a looser stool, with less danger of further complications. If the obstruction is acute or complete, a preliminary right transverse colon colostomy is made, followed by a left colectomy at a later date. If the disease is quiescent,

Fig. 2.—This is the standard operation in which the left colon is removed from the splenic flexure to the peritoneal reflection and a primary end-to-end anastomosis made. The right transverse colon colostomy can be done as a preliminary procedure or at the time of the left colectomy. At a later time the double-barrel colostomy is closed.



a left colectomy with a primary anastomosis can be done along with a right transverse colon colostomy, which is closed at a later date.

In patients with disease confined to the sigmoid, it frequently is difficult to exclude carcinoma as the cause of signs and symptoms. These patients should have a sigmoid colectomy with a primary anastomosis. However, if any degree of obstruction is present, a preliminary right transverse colon colostomy should be done.

Fistulae are most frequent between the sigmoid and the urinary bladder. The initial surgery should be a defunctionalizing right transverse colon colostomy. A very high proportion of these patients will have further difficulty if the colostomy is closed. For permanent relief, a left colectomy with excision of the fistula and closure of the bladder must be performed with the usual closure of the colostomy later. Some patients will have repeated cystitis, pyelitis, and bladder tenesmus without a demonstrable rectovesical fistula. In some such cases of diverticulitis of the sigmoid which have inflammatory adhesions between bladder and sigmoid, we have found that the patients experience prompt and permanent relief of urinary symptoms after the standard operation of resection of the sigmoid and descending colon.

In our experience we have never seen any bleeding from diverticula. Although bleeding has been reported frequently, we have found that in most such cases the bleeding comes from associated polyps or carcinoma. With careful search by x-ray, these can often be demonstrated. Fortunately, polyps are found most commonly in the same portion of bowel as is involved with diverticulitis. It has been our custom in such cases to resect the left colon and sigmoid to the peritoneal reflection and to insert a sterile proctoscope through the proximal end of the splenic flexure to make certain that there are no polyps proximal to the resected bowel. If polyps are found here, the resection is carried to the hepatic flexure and the proctoscopic examination is repeated until all polyps of the bowel are removed. An end-to-end anastomosis is then performed.

In our series there were 23 cases treated by one team, with consistent application of the same principles and techniques. Many cases had more than one indication for surgery.

Two cases were of particular interest, the first being that of a patient who developed a complete obstruction of the sigmoid after stomach fluoroscopy with barium. He had a right transverse colon colostomy with a resection of the sigmoid at a later date. When the surgical specimen was examined, there was found an actinomycotic abscess in and about an inflamed diverticulum. He has remained well for the five years since surgery. The second case was that of a 61-year-old woman who had a right transverse colon colostomy by one of us (R. K. G.) in 1942 for complete obstruction of the sigmoid due to diverticulitis. In 1952 she began to pass blood-tinged mucus from the defunctionalized left colon, and x-rays showed a filling defect in the sigmoid colon. An end-to-end anastomosis was done after resection of the descending colon and sigmoid along with the left ovary, which was buried in the mass. When the specimen was opened, it was found to contain a papilloma surrounding four diverticular abscesses of the sigmoid which were buried in the ovary. We think this is another example of a developing neoplasm in a defunctionalized bowel which was the seat of chronic inflammation, in this case very localized. Within less than a year she had recurrent papillomas near the site of anastomosis, and so the remaining left colon and rectum distal to the colostomy were removed. She has had no further trouble in the year and a half since the resection.

Ten patients had an obstructive resection; seven had a left colectomy with a primary anastomosis after a preliminary right transverse colon colostomy; four had a one-stage left colectomy with a primary anastomosis, and two severely ill patients had a descending colostomy.

Three of the 23 patients died after surgery.

CASE 1.—Patient had two previous episodes of myocardial infarction. He was bedridden for almost one-half of the preceding year because of recurrent bouts of fever, pain, and partial obstruction. By x-ray the presence of carcinoma could not be excluded. A simple obstructive resection was done, and the immediate postoperative course was uneventful until the seventh day, when he had another coronary occlusion and died.

CASE 2.—A 51-year-old patient was seen six hours after the administration of a large enema which had entered the free peritoneal cavity through a solitary inflamed diverticulum in a movable sigmoid. The freely movable perforated sigmoid was simply exteriorized; however, the patient died of generalized peritonitis.

CASE 3.—A 63-year-old patient had had a proved myocardial infarction nine years previously. He had repeated bouts of diverticulitis with occasional disability for nine years. For two weeks immediately prior to admission he had red blood in his stool. On x-ray examination there was a localized narrowing at the junction of the descending colon and sigmoid, which was suggestive of carcinoma. At surgery there was a fist-sized mass in the proximal sigmoid, with inflamed diverticula. The left ureter and the dome of the urinary bladder were adherent to this mass. After the left ureter was freed, the descending and sigmoid colon were resected and an end-to-end anastomosis was made along with a cecostomy. On the sixth postoperative day he developed a myocardial infarction, from which he died three days later. The surgical specimen showed that the bleeding was from a polyp in a portion of the sigmoid most involved with diverticulitis.

CONCLUSIONS

Our indications for surgical intervention in diverticulitis of the colon and the surgical principles to be observed are as follows:

In free perforation of a sigmoid diverticulum, obstructive resection of the sigmoid will usually suffice. If the sigmoid is not movable, the perforation is closed and drained, and a right transverse colon colostomy is done.

In patients having an abscess requiring drainage, a high proportion will have further difficulty until the diseased bowel is removed.

In patients with recurrent and disabling bouts of diverticulitis resection should be done.

Patients with rectovesical fistulae or those with repeated bouts of cystitis and pyelitis accompanying flare-up of their diverticulitis should have surgical removal of the diseased colon.

In localized diverticulitis of the sigmoid, when the diagnosis of carcinoma cannot be excluded a sigmoid resection should be performed.

When there is bleeding from the bowel in patients with diverticulitis, it must be assumed that polyps or carcinoma are also present. If these cannot be excluded, the bowel containing the diverticula should be removed and the remainder of the colon explored.

Since the descending colon usually contains many diverticula, if there is much involvement of the sigmoid the ideal operation is resection of the descending colon and sigmoid to the peritoneal reflection with an end-to-end anastomosis, usually with an accompanying right transverse colon colostomy. This operation not only removes most of the diseased bowel but leads to a looser stool, with less danger of difficulty from any remaining diverticula.

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DISEASE OF URETERAL REMNANT FOLLOWING NEPHRECTOMY

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PATIENTS who have recurring urological symptoms following nephrectomy present a special problem to the practitioner. In many cases, nephrectomy has been done for pyohydronephrosis, calculus formation, or other obvious pathology, yet the symptoms for which the patient consulted his physician persist or sometimes recur many years after the operation. We would like to reemphasize the possibility of an abnormal or diseased remaining lower ureteral segment as a possible cause for the continued symptoms.

In conditions such as papillary carcinoma of the renal pelvis and carcinoma of the ureter, removal of the entire ureter at the time of nephrectomy is universally considered the operation of choice. But in many cases, such as nephrectomy for renal tuberculosis, pyohydronephrosis, and renal calculus formation, the advisability of total nephroureterectomy is controversial. In the past few years, interest in the fate of the ureteral stump following nephrectomy has been kindled by experimental studies [1] and reports of simpler methods of ureterectomy.*

Latchem [1] has shown experimentally that if no obstruction is present in the distal ureter the ureteral remnant will atrophy with a collapsed lumen, cessation of peristalsis, and gradual clearing of infection, even when severe renal infection and ureteritis have been present prior to operation. However, if complete or partial obstruction of the distal ureteral segment is present, due to any cause, the lumen dilates. Infection if present progresses even to abscess formation and peristalsis continues. These principles have been repeatedly corroborated by clinical findings.

Reiser [5] emphasizes the necessity for determining whether or not the ureter is able to evacuate its contents as determined by retrograde injection prior to nephrectomy. If adequate evacuation of the ureter is complete one to two hours after injection, the ureteral stump left after nephrectomy should cause no symptoms, even in the face of severe infection. However, if retention is present, a stormy and troublesome postoperative course may be anticipated, and a primary nephroureterectomy should be considered.

Disease in a remaining ureteral segment should be suspected in any patient who has had a nephrectomy and who continues to have the symptoms for which the nephrectomy was done. The diagnosis is confirmed by cystoscopic visualization of pus or tumor exuding from the ureteral orifice on the suspected side and by retrograde injection of a radiopaque medium and x-rays of the suspected ureteral stump.

Within the past year we have had three postnephrectomy patients who have had sufficient symptoms and disability from the ureteral remnant to require secondary ureterectomy.

REPORT OF CASES

CASE 1.—Mrs. E. C., a 55-year-old Negro woman, entered the hospital with a two-week history of right flank pain. This pain occurred suddenly and was described as being nagging in character, with no radiation. Past history revealed that the patient had had a right nephrectomy 25 years previously for hydronephrosis. The patient had been symptomless until the present episode. Urinalysis on admission showed gross pus and 10 to 15 red blood cells per high power field. Retrograde catheterizations of the ureters revealed obstruction due to a 1.5 by

Department of Urology, The Mason Clinic (Dr. Mason) and Resident in Surgery, Virginia Mason Hospital (Dr. Coburn).

* References 2, 3, and 4.

1 cm, calculus approximately 2 cm. from the right ureterovesical junction. A moderate left pyelonephritis was also noted.

At operation an 11 cm. segment of right ureter which contained the stone was removed. The patient made a rapid postoperative recovery and left the hospital on the fourth postoperative day. She has remained asymptomatic for the past 12 months. Repeated postoperative urinalyses have been negative.

CASE 2.—Mrs. C. T., a 23-year-old married white woman was first seen in November, 1952, complaining of a draining sinus in the right flank. The patient had had a right nephrectomy for calculus pyonephrosis six months previously. The operative incision had broken down, and a chronic draining sinus presented. Several attempts were made elsewhere to excise the sinus, without success. Two weeks prior to admission the patient had had a severe episode of left pyelonephritis, which had responded temporarily to chemotherapy. On admission she had a marked urinary tract infection. There was a draining sinus in the right lower quadrant in the lower third of a previous nephrectomy wound. Cystoscopic examination was carried out. The left ureter was easily catheterized and a normal left pyelogram obtained. The right ureteral orifice could not be catheterized because of obstruction at the ureterovesical junction. The sinus in the right lower quadrant was injected with chloriodized oil (Iodochloral), and subsequent x-rays showed pooling of the radiopaque medium in the retroperitoneal space. No connection with the ureter was noted. Barium enema did not show any connection of the injected radiopaque medium with the large bowel. The possibility of infection in the remaining ureteral stump was considered, and exploration of the sinus tract was carried out. The tract led to an enlarged and purulently draining ureteral stump. Ureterectomy was done. The ureter measured 1.5 cm. in diameter and was completely obstructed at the ureterovesical junction. There was no evidence of tuberculosis on pathological examination of the tissue removed.

The patient made an uneventful recovery, and there has been no further drainage.

CASE 3.—Mr. F. H., a 70-year-old white man, was first seen in February, 1953, for hematuria which had been present for three years. The patient gave a history of a right nephrectomy in 1943. Preoperative symptoms consisted only of "bleeding on urination." No preoperative work-up and no postoperative pathological reports were available. On cystoscopy a large papillary tumor was seen exuding from the right ureteral orifice. Tissue for biopsy was obtained and reported as Grade III papillary carcinoma with probable mural infiltration. A left retrograde pyelogram was normal. Subsequent right ureterectomy was performed along with segmental resection of the bladder. Six weeks later the patient noted gross hematuria, and cystoscopy at this time revealed recurrent papillary carcinomata. The patient died approximately eight months after the operative procedure from multiple metastases. It would seem highly probable that had nephroureterectomy been carried out on this patient in 1943 at the time of the original nephrectomy, a much more favorable long-term result should have been expected.

SUMMARY AND CONCLUSIONS

Three cases requiring secondary ureterectomy are presented. The pathologic physiology of the ureteral remnant is briefly reviewed: If no obstruction is present in the distal ureter, the ureteral remnant will atrophy with a collapsed lumen, cessation of peristalsis, and gradual clearing of infection. However, if complete or partial obstruction of the distal ureteral segment is present owing to any cause, the lumen dilates. Infection, if present, progresses even to abscess formation, and peristalsis continues.

A plea for consideration of total ureterectomy at the time of nephrectomy in selected cases is entered. In our experience, if nephroureterectomy is done when indicated, an appreciable number of patients will not have early or late unfavorable postoperative sequelae. These include continuing urinary tract infections, persistence of symptoms, or possible further spread of carcinoma.

Total ureterectomy is indicated when nephrectomy is done for papillary carcinoma of the renal pelvis or ureter, impacted or retained stones in the distal ureter, renal tuberculosis, and demonstrable ureterovesical obstruction causing delay in emptying time of the distal ureter.

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MEDICAL AND SURGICAL TREATMENT OF CRYPTORCHIDISM

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INTRODUCTION AND LITERATURE

WE BECAME interested in the problem of the treatment of cryptorchidism for several reasons. The literature and local customs agree in diversity of opinion relative to medical and surgical treatment, indications for, and timing of, therapy. Usually, when such multiplicity and variation of management of a medical problem occur, none of the methods produce uniformly satisfactory results. Our experience and the evalution of the problem suggest that much of the confusion is unnecessary.

Study of the literature suggests that the age for surgical intervention varies from less than 1 year to even after puberty (12 years, plus or minus). Some authors indicate 6 to 9 years as the optimum time for operation. The Bevan and the Torek procedure are the most popular of those advised. A few authors suggested the possible advantage of incision of the transversalis fascia, division of the deep epigastric vessels, and retroperitoneal dissection, but only two emphasized this point as the sine qua non of success.* Until the 1953 publication of R. E. Gross' book,[9] the poor illustrations in the literature indicated failure to grasp the basic anatomic principles of orchidopexy.

In many areas general surgeons and/or general practitioners treat as many patients with cryptorchism as do urologists, perhaps more. Personal observation of all three categories of surgeons indicates general disregard of basic principles and poor technical execution of the operation in some. The paucity of patients, preventing wide experience in development of technical skill in any individual surgeon, may be the chief explanation of the deficiency.

Wide difference of opinion for timing and dose of chorionic gonadotropins is found in the literature. Amounts listed vary from none to 30,000 I. U. or more in one or multiple courses. Most felt 3,000 to 6,000 units in one or two courses was optimum. The age span indicated was 1 to 12 years; the 6-to-9-year time was most frequently selected. Descent of the testis is expected within eight weeks after hormone treatment by some, and if it has not occurred immediate orchidopexy is advised. Others advise surgical intervention immediately after the last injection, while still others postpone surgery until puberty.

The following comments and opinions are based on study of the literature,† personal observation, and experience with a small series of private patients and patients observed in a large university hospital and a large county hospital. The private series is too small (62) to be of statistical importance and is not presented in this manner.

MEDICAL TREATMENT

It is wise to make careful multiple examinations to exclude alternating cryptorchism, ectopic testis, or hypoplasia of the testis and cord. During this observation period, the parents should be informed relative to the mechanism, reasons, possible absence or hypoplasia of the testis, possible short spermatic vessels, and probable presence of a hernia.

Read before the Section on Urology at the 103rd Annual Meeting of the American Medical Association, San Francisco, June 24, 1954.

* References 9 and 14.

† References 1 through 20; Flocks, R. H., and Bunge, R. G.: Personal communication to the authors, December, 1953; Robinson, J. R.: Personal communication to the authors, June, 1954; Smith, D. R.: Personal communication to the authors, May, 1954.

Trusses should not be advised for patients with hernia.

Chorionic gonadotropins (Antuitrin "S," or Follutein) should be given in the sixth year and again just before puberty (10th to 12th year). The dose should be 300 to 500 I. U. given intramuscularly two to three times weekly for a total of 3,600 to 9,000 I. U. in each of a maximum of two courses. The smaller dose is reserved for the younger or small patients; the greater, for the older or larger boys or for those with bilateral cryptorchidism and/or hypogenitalism. No instance of precocious puberty or other side-effect was encountered, although careful observation for such a result was maintained.

We have never seen a testis appear as a result of gonadotropic therapy. It is employed because it might help, to mollify the parents while temporizing, and to aid genital growth, enlarge the local structures, and improve blood supply, preliminary to surgical correction. No direct evidence proving the increased blood supply has been discovered by us.

Testosterone proprionate injection in doses of 25 to 50 mg. intramuscularly twice weekly is advisable in hypogenitalism with bilateral or unilateral undescended testis if the gonadotropins have had no effect. The age indication is the same as for gonadotropins. The total dose is guided by the genital growth. When the desired increase has been obtained to make surgical intervention applicable, testosterone is discontinued. If subsequent observation and surgical exploration indicate bilateral agenesis or hypoplasia, maintenance doses become necessary at puberty. Testosterone is not employed to cause descent of the testis.

The Ballenger suction method of treatment is not satisfactory to patient, family, or physician.

SURGICAL TREATMENT

Indications.—Orchidopexy is indicated in bilateral or unilateral absence of the testis from the scrotum before puberty. The optimum time for operation is just before puberty or about the 10th to the 12th year. Operation should be preceded by a course of chorionic gonadotropin; testosterone is used if the anterior pituitary-like hormone fails to enlarge the genitalia. The reason for awaiting the prepubertal time is to allow possible, but improbable, spontaneous descent and to permit the increase in size of the genitalia for ease in technique. Younger children suffering from troublesome hernia may require earlier orchidopexy to relieve the hernia.

Because of past experience, we have selected arbitrarily the 10th to the 12th year for elective orchidopexy. However, there is good evidence for earlier operative intervention. The debate can be settled finally within 20 years by the establishment of testicular biopsy banks. Through the leadership and cooperation of Dr. Donald R. Smith, in San Francisco,‡ Dr. Rubin Flocks, and Dr. Raymond Bunge,§ in Iowa City, and Dr. John N. Robinson and Dr. Earl Engel,‖ of New York City, centers for testicular biopsy study and preservation have been established in the East at Columbia University, in the Midwest at the University of Iowa, and in the Far West at the University of California. All surgeons should obtain biopsies from each testis transplanted and the normal mate, preserve them in Bouin's solution, and send to the nearest of these centers. Then, after the patient has entered active sexual life, the semen should be studied and new testicular biopsies obtained and sent for comparative study. Thus the problem of timing of operation will be settled.

The danger of a malignant condition in an undescended testis is not a primary indication for orchidopexy. Many statements are made in which the danger of a malignant process is given as an indication for operation, but little or no convincing evidence is presented with these opinions. We feel that the operation should be done only before puberty for

‡ Personal communication to the authors.

§ Personal communication to the authors, December, 1953.

‖ Personal communication to the authors, June, 1954.

the prime reasons of saving a testis, or proving hypoplasia or absence of testis from the pelvis. After puberty, local exploration, bilateral or unilateral, is acceptable for cosmetic reasons, to establish presence or absence of a gonad in the pelvis or inguinal area, to prove hypoplasia, or to repair a hernia, but not to transplant or remove a testis for fear of a future malignant lesion.

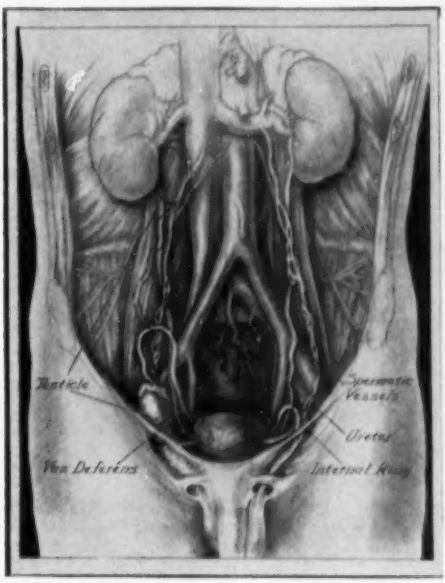


Fig. 1.—General relationship of spermatic cord and testis.

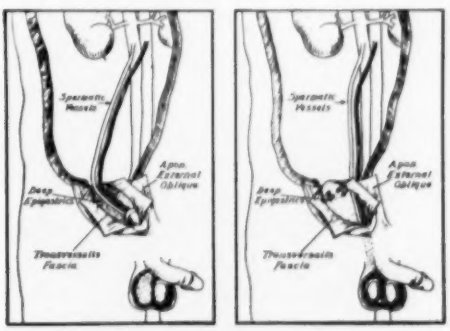
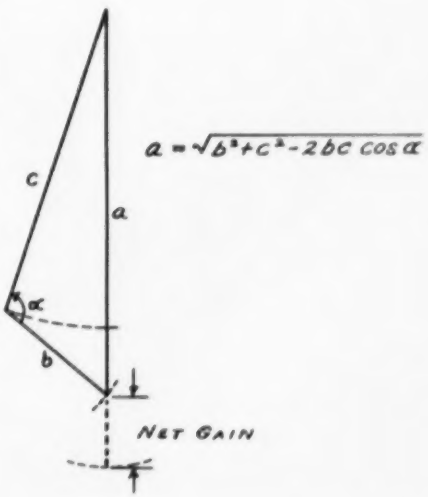


Fig. 2.—Left: Oblique schematic view to illustrate spermatic triangle.

Right: Cord elongation through medial displacement by elimination of lateral and inferior sides of spermatic surgical triangle.

Fig. 3.—Aortogram illustrating right spermatic artery and the spermatic surgical triang'e. Courtesy of Dr. John Greenleaf, Iowa City.

Fig. 4.—Geometric figure and trigonometric formula illustrating spermatic surgical triangle and relative gain in cord length by medial displacement.



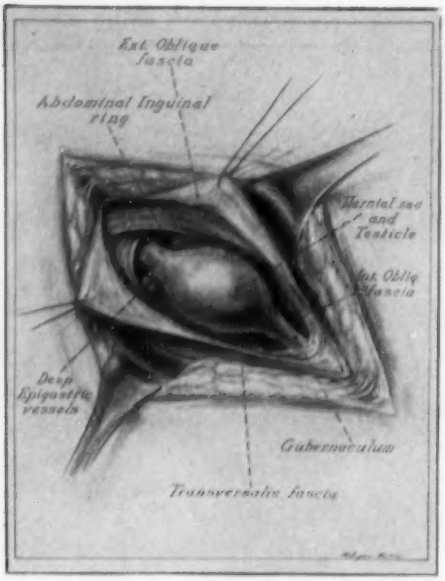


Fig. 5.—Anatomy of inguinal canal with contained testicle.

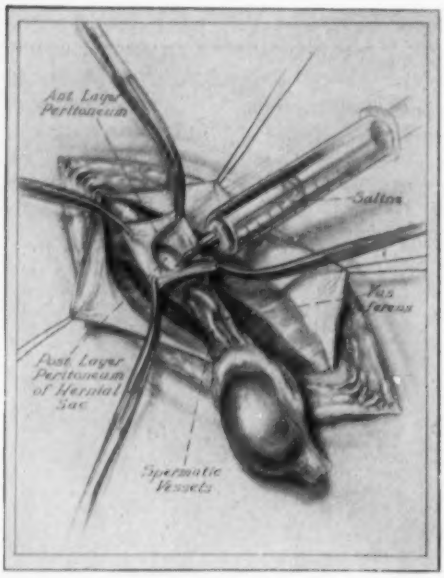


Fig. 7.—Isolation and separation of hernial sac from cord with sodium chloride solution.

The unilateral undescended testis casually found in adults is best left alone. If the possibility of a malignant condition is used alone as an indication for operation, the surgeon must be prepared to explore the peritoneum and retroperitoneum to the level of the renal

Fig. 6.—Transversalis fascia, deep epigastric vessels divided.

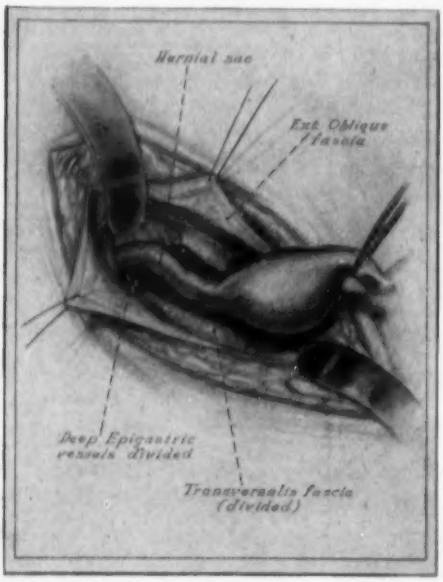
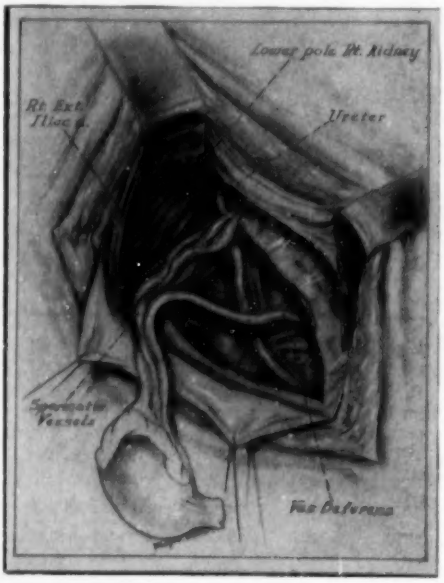


Fig. 8.—Development of retroperitoneal space for medial displacement of spermatic vessels.



hilum, bilaterally, if consistency of indication is maintained. And then the testis might not be found. This would be an extremely extensive procedure for the patient to undergo with little gain promised in view of the poor evidence of danger of a future malignant condition in the possible case of cryptorchidism.

Principles and Pertinent Anatomy.—There are five important points in the surgical anatomy (Fig. 1) incident to orchidopexy (Figs. 2, 3, 4, 5, and 8): (1) the spermatic surgical triangle, defined herein (Figs. 2, 3, 4, and 11); (2) the retroperitoneal space,

Fig. 9.—Upper: Peritoneum replaced, adequate cord length obtained.

Lower: Dissection within cord unnecessary and harmful.

which lends itself to easy development and makes possible elimination of the lateral side of the triangle (Fig. 8); (3) the transversalis fascia, or floor of the inguinal canal (Fig. 6); (4) the deep epigastric vessels, division of which allows elimination of the inferior side of the spermatic surgical triangle (Figs. 5 and 6), and (5) the Dartos fascia of scrotum, incision of which permits a lower testis in a poorly-developed scrotum.

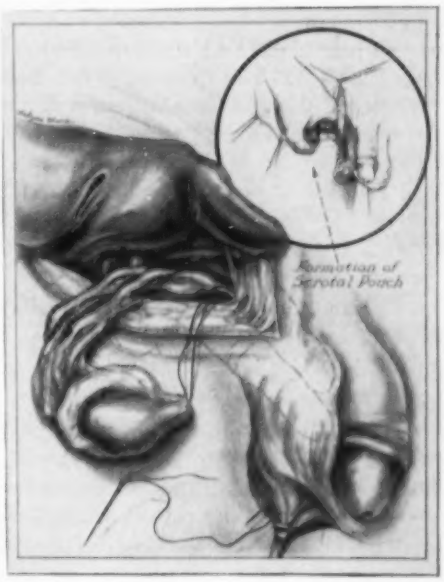


Fig. 10.—Fixation of testis in most posteroinferior portion of scrotum.

The aim of the operation of orchidopexy is to place the testis low in the scrotum while preserving a good blood supply and an un-

Fig. 11.—Note old and new routes of spermatic cord and relative gain in length of cord. Spermatic cord leaves abdomen through external ring only.

interrupted vas deferens. This can be accomplished best if the cord structures are disturbed the least. The spermatic vessels and vas deferens follow a tortuous course in the retroperitoneum (Figs. 1 and 8). The vessels pass laterally to the internal ring from their origin in or near the renal vessels and then medially down the inguinal canal to the scrotum. The vessels traverse two sides of the spermatic surgical triangle (Figs. 2, 3, and 4). The boundaries of the spermatic surgical triangle are the following: medial—midline of the body; lateral—abdominal course of the spermatic vessels; inferior—inguinal course of the spermatic vessels. Therefore, elimination of tortuosity of vessels, medial displacement, and substitution of the medial (external ring) for the normal lateral (internal ring) exit from the retroperitoneum will cause the vessels to describe only one side of the spermatic surgical triangle (Figs. 2, 4, and 11). This procedure takes advantage of the fact that a straight line is the shortest distance between two points. Incision of the floor of the inguinal canal (transversalis fascia), division of the deep epigastric vessels, and reflection of the peritoneum permit this relative increase in length through decreasing distance (26%) to the scrotal pouch without danger to blood supply or vas deferens (Fig. 4). This is the most important surgical-anatomic principle.

Elimination of cord coverings, including peritoneum, cremaster, internal and external spermatic fascia, and some fibrous bands, with great care, will gain some actual length.

Creation of adequate scrotal pouch and fixation of the testis are the last important points in the surgical care.

TECHNICAL DETAILS

1. Make a routine, but generous, inguinal incision, curving to the superior border of the scrotum, avoiding possible displacement of the testis above the external ring.

2. Open the fascia of the external oblique muscle after cleaning off adipose tissue.

3. Isolate the ilioinguinal nerve. Clean the conjoined tendon and the shelf of Poupart's ligament.

4. Elevate the cord and sac (with contained testis) from above, downward.

5. Free the sac from above in order to avoid branches of the ilioinguinal nerve. Delineate the transversalis fascia (Figs. 5 and 6). Make a scrotal pouch.

6. Retract the internal oblique muscle at the internal inguinal ring. If necessary, incise this muscle laterally.

7. With moderate tension on the spermatic cord, dissect retroperitoneally, delineating the internal ring and defining the lateral edge of the transversalis fascia at the internal ring (Figs. 5 and 6).

8. Reflect the peritoneum upward from the transversalis, down to the pubic tubercle, avoiding the bladder (Fig. 8).

9. Incise the transversalis fascia from the internal ring to the pubis, isolating and ligating the deep epigastric vessels (Fig. 6).

10. Open the hernial sac. Elevate the peritoneum from the cord with isotonic sodium chloride solution (Fig. 7). Incise and dissect the peritoneum from the cord. Close the hernial sac with a running suture.

11. Now carry out the deep retroperitoneal dissection, retracting the peritoneum and anterior abdominal wall for clear lighting and vision, even to the origin of the vessels and the vas deferens, if necessary. The length of the vas is rarely a problem (Fig. 8).

12. Shift the cord and testis to the external ring and judge the length obtained.

13. Remove the distal coverings of the cord to the testis. Transmitted light may aid recognition of vessels in this dissection.

14. Pierce the tunica albuginea of the lower pole of the testis with No. 1 chromic absorbable surgical (gut) suture. Bring both ends through the depth of the scrotum with straight needles. From outside, mark the lowest part of the scrotal pouch (Fig. 10) with an Allis clamp. Do not create a tunica vaginalis about the testis because of danger of future hydrocele.

15. After the operation is complete, set up rubber band traction of the anchoring suture or fix the suture to the skin of the thigh (Fig. 11).

16. Close the transversalis fascia, suture the conjoined tendon and internal oblique to the shelf of Poupart's ligament, and close the external oblique fascia (Fig. 11). Close the scrotal entrance with interrupted sutures.

17. Place subcutaneous interrupted sutures. Close the skin with clips, absorbable surgical (gut) suture or subcuticular stitch.

The patient is up the next day and home on the sixth or seven postoperative day. The fixation suture releases itself in 6 to 10 days. In bilateral cryptorchidism, the opposite side should be done one week later.

OTHER METHODS AND DISCUSSION

The Bevan technique is the one usually employed. This involves closing the hernial sac, making minor retroperitoneal dissection, and removing cord coverings and fibrous tissue (and usually much of the blood supply) from the internal ring to the testis. The testis is fixed in the scrotum with a piercing suture placed in rubber band tension after Ferguson type repair of the inguinal canal. This method fails to take advantage of the shortest-distance principle of the spermatic surgical triangle in transplantation. Some authors advocate bringing the testis under or cutting the deep epigastric vessels but do not emphasize wide and deep retroperitoneal dissection to gain a straight, medial retroperitoneal course for the spermatic vessels. The Bevan method relies on giving length to the cord by dissection, chiefly from the internal ring outward.

The Torek method admits defeat. If cord, vessels, and vas deferens are properly lengthened by medial displacement and straightening, there is no need for fixation of the testis to the fascia of the inner thigh. If the testis can be brought into the scrotum only by such tension that suture to the thigh fascia is required to hold it there, the testis will atrophy, owing to tension ischemia. If the spermatic vessels or the vas are congenitally too short to reach the scrotum, no degree of tension and fixation will insure survival of the testis. In these few cases, it is better to admit this fact rather than to subject the youngster to a tug on the testis, vas, and cord (not to mention the vena cava and the aorta) with each step, and still to end up with a sensitive withered testis. The only real indication for a Torek procedure is agenesis of the scrotum. Even then, if time and gonadotropins are employed, the scrotum will develop prior to surgery. In the emergency repair of the hernia with undescended testis associated with agenesis of the scrotum, surgical enlargement of the scrotum by the Torek method is indicated.

The permanent location and condition of the testis can be decided in about four months, but observation up to one year is desirable before final classification of result.

SUMMARY

The reasons for this discussion, our medical treatment, the pertinent surgical anatomy, the principles of orchidopexy, and our technique have been presented. The spermatic surgical triangle has been defined. Other methods have been discussed and largely rejected. In our hands, the methods presented have given uniformly good results.

A plea is presented to use testicular biopsy banks at Columbia University, in the East, the University of Iowa, in the Middle West, and the University of California at San Francisco, in the West, in order to finally settle the timing of orchidopexy.

3415 Sixth Ave.

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RELATION OF THYROID NEOPLASMS TO HASHIMOTO DISEASE OF THE THYROID GLAND

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THE SIMULTANEOUS occurrence of a neoplasm and Hashimoto disease (Hashimoto "thyroiditis," lymphadenoid goiter, struma lymphomatosa) in a thyroid gland has been noted infrequently. In a study concerned primarily with the clinical aspects and pathogenesis of various types of thyroiditis, a significant statistical relation was found between malignant thyroid neoplasms and Hashimoto disease of the thyroid gland. Thirty-seven malignant neoplasms were observed in 302 glands which also displayed the characteristic lesions of Hashimoto disease, a frequency which would occur by chance less than 1 time in 1,000.[1]

The present study was concerned with 73 patients who had benign or malignant thyroid epithelial neoplasms associated with Hashimoto disease of the thyroid gland. Included in the study for comparative purposes were 207 patients who had only benign or malignant thyroid epithelial neoplasms and 205 patients who had Hashimoto disease without thyroid neoplasms (Table 1). All patients were observed during the last 10 years (1944 through 1953) by members of the Thyroid Clinic of the University of California School of Medicine. The histologic classification and grading of thyroid neoplasms proposed by Warren [2] were used in this study.

The purpose of this report is to review the clinical and pathologic relationships between thyroid epithelial neoplasms and Hashimoto disease and to demonstrate that the association of these two lesions is not fortuitous.

TABLE 1.—*Thyroid Neoplasms and Hashimoto Disease Found in 2,336 Thyroid Glands Removed*

	Cases	
	No.	Total
Hashimoto Disease		
Hashimoto disease without neoplasm	205	...
Adenoma with Hashimoto disease (2 also showed carcinoma)	38	...
Carcinoma with Hashimoto disease (2 also showed adenoma)	35	278
Adenomas		
Adenoma with Hashimoto disease (2 also showed carcinoma)	38	...
Adenoma without Hashimoto disease (5 also showed carcinoma)	92	130
Carcinomas		
Carcinoma with Hashimoto disease (2 also showed adenoma)	35	...
Carcinoma without Hashimoto disease (5 also showed adenoma)	115	150

STATISTICAL STUDY [13]

The incidence of adenomas in the group of glands with Hashimoto disease (18.5%) as compared to the incidence in the group without Hashimoto disease (4.3%) appeared to be significant. To test the significance of the higher incidence, assuming that no relationship exists, the maximum number of cases of the two diseases occurring together, which would be expected at a probability level of 1 chance in 1,000 ($P = 0.001$), was determined. This was found to be 25.5 cases,

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or an incidence of 12.4%. Assuming that no relationship exists between the two diseases, the chances are 1 in 1,000 that not more than 25.5 cases of adenoma would be found in the Hashimoto group. Since the incidence of adenomas with coexistent Hashimoto disease was in fact 18.5% (38 cases), this is significant well beyond the 1 to 1,000 limit, and some relationship between the two processes probably exists.

In a similar fashion, the maximal incidence of thyroid carcinoma with coexistent Hashimoto disease was determined, assuming no relationship, again with the probability set at the 1 to 1,000 level. This was found to be 29.6 cases of carcinoma, an incidence of 14.4%. Since the actual incidence was 17.7% (35 cases), it appears that a relationship exists between thyroid carcinoma and Hashimoto disease.

Similarly the chances of seven (the observed incidence) or more cases of carcinoma occurring with coexistent adenoma in glands with Hashimoto disease, assuming no relationship, was determined to have a probability of $P = 0.75$. Therefore, this incidence is well within the range of chance sampling, and no relationship is demonstrated between adenomas and carcinomas in thyroid glands with Hashimoto disease.

CLINICAL STUDY

The clinical information available on 353 patients in this study is summarized in Table 2. No significant differences existed between the groups in regard to the patient's age, the duration of goiter, its growth, and a family history of goiter. Significant differences were (1) the higher incidence of Hashimoto disease in women, (2) the higher incidence of residence in endemic areas of patients with adenoma associated with Hashimoto disease as compared to patients having adenoma without Hashimoto disease, and (3) a lower frequency of pressure effects in patients with both carcinoma and Hashimoto disease.

TABLE 2.—*Clinical Data on Patients with Thyroid Neoplasms and Hashimoto Disease*

	Hashimoto Disease Without Neoplasm (110 Cases)	Adenoma with Hashimoto Disease (36 Cases)	Carcinoma with Hashimoto Disease (35 Cases)	Adenoma Without Hashimoto Disease (87 Cases)	Carcinoma Without Hashimoto Disease (85 Cases)
Sex	90% F.	89% F.	98% F.	87% F.	76% F.
Age at onset					
Range	6-73 yr.	20-69 yr.	9-66 yr.	3-72 yr.	8-68 yr.
Mean	38.3 yr.	36.5 yr.	37.5 yr.	33.2 yr.	36.0 yr.
Unknown	3.6%	0.0%	6.0%	3.4%	10%
Age at operation					
Range	14-75 yr.	21-73 yr.	9-66 yr.	13-72 yr.	8-88 yr.
Mean	46.2 yr.	47.4 yr.	41.3 yr.	44.5 yr.	44.1 yr.
Endemic residence	51%	44%	34%	28%	39%
Family history	24%	19%	24%	18%	10%
Duration of goiter					
Range	1 yr. or less: 40%	25%	45%	37%	22%
	1-10 yr. 35%	50%	43%	37%	39%
	Over 10 yr. 21%	25%	6%	22%	28%
	Unknown: 4%	0.0%	6%	4%	11%
Growth of goiter	50%	47%	40%	65%	49%
Pressure effects	60%	58%	20%	39%	50%

PATHOLOGIC STUDY

Hashimoto disease is generally regarded as a noninflammatory metabolic process of the thyroid gland characterized by epithelial degeneration, lymphoid infiltration, and fibrosis. Although the disease has been extensively studied since 1912, there is now little agreement as to its nature, pathogenesis, and classification.* The basic lesions in the thyroid gland may be either focal or distributed diffusely and may exist without thyroid enlargement or other clinical fea-

* Graham, A.; Frantz, V. K.; Klinck, G. H.; Levitt, T.; Meissner, W. A., and Winship, T.: Personal communication to the authors.

tures usually associated with classic Hashimoto disease.[1]

Most investigators have stressed the epithelial degenerative phases, the lymphoid infiltration, and the fibrosis as the significant lesions of this thyroid disease. Williamson and Pearse,[2] however, first noted the pronounced epithelial overgrowth in these glands and described islands of solid epithelial tissue which filled the follicular spaces and displayed considerable mitotic activity.

The thyroid lesions observed by McCarrison † in rats fed a deficient diet were remarkably similar to those described by Williamson and Pearse.[4] Solid masses of proliferating epithelial cells with mitoses displaced the intrafollicular colloid. Here and there, the solid epithelium became vesiculated and accumulated new colloid. Vesicular budding, characteristic of the experimentally produced hyperplastic goiter, however, did not occur.

Our studies of the pathogenesis of Hashimoto disease [1] revealed that the earlier phases of the process consisted of proliferation of solid groups of epithelial cells within preexisting thyroid follicles (Fig. 1). During this regenerative phase numerous mitoses were found. Later, small follicles appeared in these epithelial groups, and these newly formed microfollicles began to accumulate colloid (Fig. 2). In our studies, there was no evidence at any stage of the disease of development of microfollicles from external budding of the original thyroid follicles, a concept proposed by Stein.‡

In Hashimoto disease the epithelial proliferation is accompanied, and later overshadowed, by lymphocytic and fibrous proliferation. Neoplasms derived from each of these growing tissues might be expected. Thus, we have studied four patients in whom lymphosarcoma of the thyroid gland was associated with the lesions of Hashimoto disease.§ Kellett and Sutherland [7] previously noted the association of lymphosarcoma and Hashimoto disease. In a case of thyroid fibrosarcoma containing giant cells reported by Rather [8] the lesions of Hashimoto's disease were also present.

In addition to the diffuse intrafollicular growth of thyroid epithelium characteristic of Hashimoto disease, localized nodular epithelial lesions also occur. In some cases the nodules found in these glands are involutionary and consist of enlarged colloid-filled follicles (Fig. 3).[9] In other cases the nodules are formed by hyperplastic follicles, which suggests that they are compensating for the damaged, relatively inactive tissue of the remainder of the gland. The frequent occurrence of Askanazy changes (Hürthle cells) in the nodules [10] indicates that the cells comprising the nodules are subjected to the same influences that affect the remainder of the glandular epithelium. These cells are believed to be exhausted owing to excessive thyrotrophic stimulation.

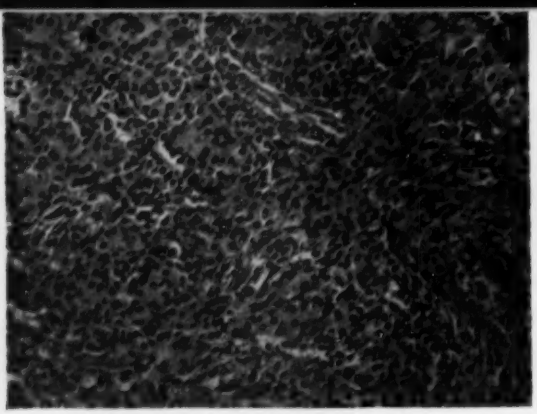
Benign neoplasms are also observed in glands displaying Hashimoto disease. While these adenomas, as a rule, can be differentiated histologically from involutionary nodules, it is likely that some of the lesions which closely resemble adenomas originate as involutionary nodules but later display considerable epithelial growth activity.[9] The adenomatous tissue may show Askanazy cellular changes and lymphoid infiltration and may thus duplicate to some extent the pattern of the surrounding gland (Fig. 4). In two irradiated thyroid glands displaying both Hashimoto's disease and multiple benign neoplasms, the development of encapsulated benign adenomas could be traced to focal epithelial proliferation in the Hashimoto process (Fig. 5 and 6).[11]

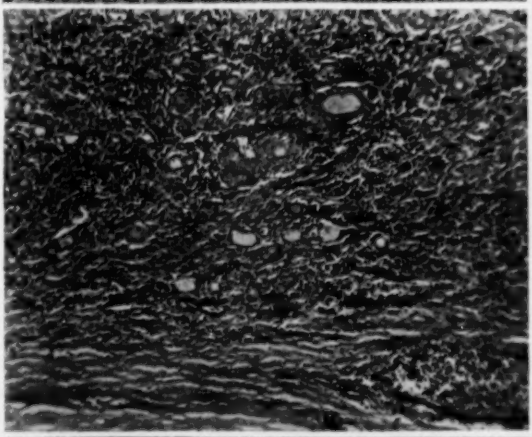
Of the 36 adenomas found in glands with Hashimoto disease, 11 (30.5%) were of the Hürthle-cell type, whereas of 87 adenomas observed during the same 10-year period in glands without Hashimoto disease, only 10 (11.4%) were Hürthle adenomas. This frequency of Hürthle-cell adenomas associated with Hashimoto disease suggests that the adenomatous cells, like those of involutionary nodules, are affected by the same fac-

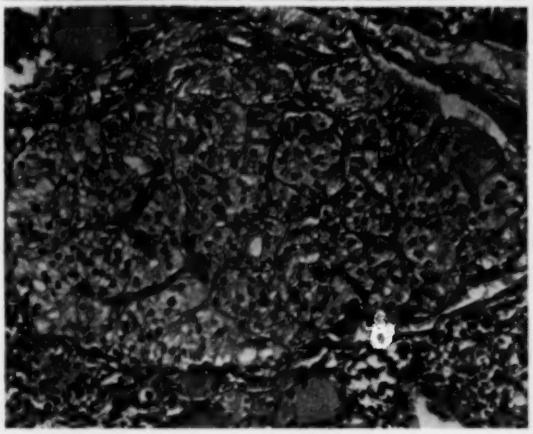
† References 4, 5, and 6.

‡ Stein, A. A.: Personal communication to the authors.

§ Lindsay, S., and Dailey, M. E.: Unpublished observations.







Figures appear in order from top to bottom.

Fig. 1.—Early intrafollicular proliferation of epithelial cells in Hashimoto disease. Numerous mitotic figures are present at this stage. Askanazy changes are not present. Hematoxylin and eosin; reduced ¼ from mag. × 186.

Fig. 2.—The intrafollicular epithelium is reorganizing and forming small thyroid follicles, some of which have accumulated colloid. Hematoxylin and eosin; reduced ¼ from mag. × 186.

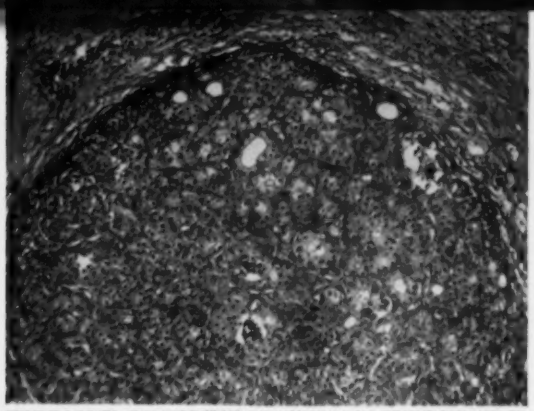
Fig. 3.—Early encapsulated involutionary nodule in Hashimoto disease. The follicles are large and most epithelial cells display Askanazy changes. Hematoxylin and eosin; reduced ¼ from mag. × 90.

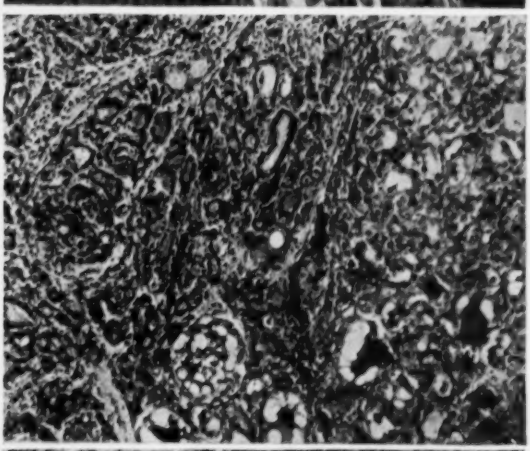
Fig. 4.—Margin of encapsulated adenoma in Hashimoto disease. Many of the adenomatous epithelial cells show Askanazy changes, and there is considerable lymphoid infiltration of the stroma of the adenoma. Hematoxylin and eosin; reduced ¼ from mag. × 90.

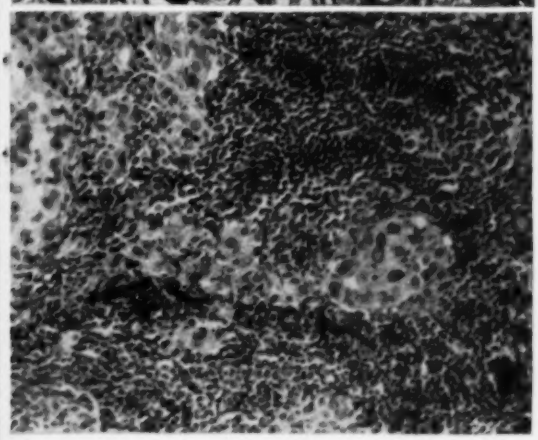
Fig. 5.—Early small adenoma composed of uniform epithelial cells with vacuolated cytoplasm. Groups of similar cells were observed elsewhere in this Hashimoto gland. Hematoxylin and eosin; reduced ¼ from mag. × 186.

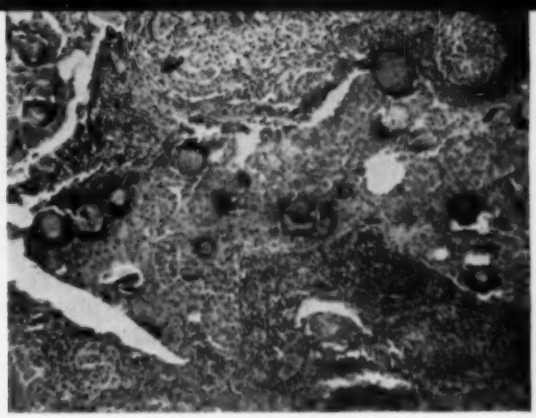
tors which produce Askanazy changes (Hürthle cells) in the remainder of the gland (Fig. 7). Our studies suggest that not all Hürthle-cell nodules are neoplasms but that some are involutionary nodules in which Askanazy changes have occurred. These concepts have been discussed by Lennox.[12]

These histologic studies indicate that the majority of malignant neoplasms found in glands with Hashimoto disease probably arise directly from proliferating epithelium of the Hashimoto process (Fig. 8). In some glands, particularly those with small malignant lesions found incidentally, proliferating epithelium transitional between that of the Hashimoto process and of the neoplastic tissue was observed (Fig. 9). In four cases in the present study glands displaying Hashimoto disease also showed diffuse lymphatic permeation with papillary carci-









Figures appear in order from top to bottom.

Fig. 6.—Same gland as shown in Figure 5. This adenoma is similar but larger and is surrounded by a fibrous capsule. Hematoxylin and eosin; reduced ¼ from mag. × 90.

Fig. 7.—Margin of Hürthle-cell adenoma in a gland with Hashimoto disease. Large lymphoid follicles were observed throughout this thyroid gland. Hematoxylin and eosin; reduced ¼ from mag. × 90.

Fig. 8.—On the left is thyroid parenchyma displaying the pattern of Hashimoto disease. On the right is the margin of an early, small adenocarcinoma which is locally infiltrating the thyroid gland. Hematoxylin and eosin; reduced ¼ from mag. × 90.

Fig. 9.—This Hashimoto gland contained an early small adenocarcinoma. The photomicrograph shows groups of atypical proliferating epithelial cells found in the Hashimoto process throughout the gland. These cells do not appear malignant but are more pleomorphic than most of the thyroid epithelium of the Hashimoto lesion. Hematoxylin and eosin; reduced ¼ from mag. × 186.

Fig. 10.—Thyroid gland with Hashimoto disease also displaying diffuse lymphatic infiltration with papillary carcinoma. Note numerous psammoma bodies. Hematoxylin and eosin; reduced ¼ from mag. × 90.

noma without an evident localized primary malignant lesion (Fig. 10). Although both adenoma and carcinoma may be found in the same gland involved by the Hashimoto process, the statistical data suggest that benign and malignant neoplasms represent independent processes, each related to the Hashimoto process but not to each other.

The comparative pathologic data shown in Table 3 indicate that clinically unsuspected malignant neoplasms occurred with equal frequency in glands with and without Hashimoto disease. These were usually small lesions or those not palpable. Papillary lesions and neoplasms of lower grades of malignancy [2] occurred with significantly greater frequency in glands also displaying Hashimoto disease, whereas nonpapillary and anaplastic malignant neoplasms were found less

often in association with the Hashimoto process. A higher percentage of carcinomas associated with Hashimoto disease metastasized to cervical lymph nodes than was the case of carcinomas not associated with Hashimoto disease. This is probably related to the higher incidence of papillary neoplasms of lower grades of malignancy in the Hashimoto group.

TABLE 3.—*Comparison of Pathologic Features of Carcinoma of Thyroid Gland with and Without Hashimoto Disease*

	Carcinoma with Hashimoto Disease (35 Cases)		Carcinoma Without Hashimoto Disease (85 Cases)	
	%	%	%	%
Carcinoma not suspected clinically	20	..	21	..
Metastases to regional lymph nodes	42	..	23	..
Diagnosed clinically	..	17	..	13
Diagnosed histologically only	..	25	..	10
Grade of Neoplasm				
I	..	57	..	14
II	..	39	..	68
III	..	4	..	18
Type of Neoplasm				
Papillary	..	83	..	41
Nonpapillary	..	17	..	59

TABLE 4.—*Comparative Ten-Year Follow-Up Data on Patients with Thyroid Carcinoma With and Without Hashimoto Disease*

	Carcinoma with Hashimoto Disease (35 Cases *)			Carcinoma Without Hashimoto Disease (56 Cases †)		
	Alive	Alive with Neoplasm	Dead	Alive	Alive with Neoplasm	Dead
0 to 6 mo.	7	..	..	1	..	9
6 to 12 mo.	0	..	..	..	..	4
1 to 2 yr.	3	..	..	..	..	1
2 to 3 yr.	5	..	..	..	..	1
3 to 4 yr.	2	1	..	..	..	2
4 to 5 yr.	4	..	1	1	..	2
5 to 10 yr.	10	..	1	21	1	6

* One patient lost to follow-up.

† These patients had thyroidectomy between July, 1935, and May, 1947. Those surviving over 10 years are not included in this Table. Seven patients were lost to follow-up.

The comparative follow-up data presented in Table 4 show that patients with thyroid carcinoma in glands without Hashimoto disease tended to die sooner after surgery than the group of patients with combined thyroid carcinoma and Hashimoto disease. Of the two patients in the group with carcinoma plus Hashimoto disease who died, one died of thyroid carcinoma with metastases. Of the 25 patients with thyroid carcinoma without Hashimoto disease who died, 18 died of thyroid carcinoma, usually with local recurrence or distant metastases. The differences in survival in the two groups is a reflection of the differences in grade and type of malignancy.

SUMMARY AND CONCLUSIONS

There are significant relationships statistically shown between thyroid carcinoma and Hashimoto disease and between thyroid adenoma and Hashimoto disease. However, there is no evident relationship between adenoma and carcinoma in thyroid glands affected by the Hashimoto process.

Clinical data do not aid in the differentiation of patients with thyroid neoplasms alone from those with thyroid neoplasms associated with Hashimoto disease.

Hürthle-cell adenomas are found in glands with Hashimoto disease with significantly greater frequency than in glands free of the Hashimoto process.

From the histologic study it was concluded that carcinoma in a gland with Hashimoto disease usually originates from the proliferating epithelium of the Hashimoto process rather than from a previously benign neoplasm.

Malignant neoplasms associated with Hashimoto disease are usually papillary and of lower grades of malignancy. This finding relates to apparent longer survival of patients with thyroid carcinoma when there is coexistent Hashimoto disease.

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ROUX-Y OPERATION VS. PARTIAL GASTRECTOMY

Further Consideration of Treatment of Lesions of Common Duct and Pancreas: Review of Five Cases

H. M. BLEGEN, M.D., Missoula, Mont.

IN RECENT years the Roux-Y operation has been used with increasing frequency in the treatment of common duct strictures,[4] pancreatitis,[5] pancreatic cysts,* and other lesions of the common duct [6] requiring anastomosis of the biliary tree to the gastrointestinal tract (Figs. 1 and 2). Although the immediate postoperative results in many of the reported cases seem satisfactory, it might be well, before accepting this operation for general use, to consider its theoretical shortcomings. The operation in effect produces a modified Mann-Williamson preparation, in which the bile (strictures) or pancreatic secretions (pancreatic cysts) are shunted to a lower level in the gastrointestinal tract.

Dragstedt† has convincingly confirmed the view that total deviation of the alkaline juices of the duodenum into the lower gastrointestinal tract results in a high incidence of gastrojejunal ulcer formation. This is due, in part, to the decrease in the neutralizing and buffering action of pancreatic juice, bile, and succus entericus and also to the resultant hypersecretion of gastric juice. Although the effect of partial exclusion of the duodenal contents has not been so clearly demonstrated, ample evidence suggests a similar outcome. After gastroenterostomy the frequency of gastrojejunal ulcer is in direct proportion to the distance of the gastroenteric stoma from the ligament of Treitz. Kiriluk and Merindino [7] have shown that this is due not to any difference in the inherent sensitivity of the gastrointestinal mucosa but rather to a progressive decrease in the buffering capacity of the bowel contents as the distance from the pylorus is increased. Therefore, any decrease in the buffering capacity of the duodenal secretions, as would occur in the Roux-Y operation, would favor the formation of peptic ulcer. Farmer and Smithwick [6] studied four cases in which the duodenal and pancreatic juices were partially diverted by a duodenostomy tube inserted at the time of gastric resection for duodenal ulcer, with a resultant increase in gastric acidity to a point at which "recurrent ulceration was highly probable." Owens [10] has shown that the incidence of postoperative gastrojejunal ulceration is high after improper reconstruction of the gastrointestinal tract after resection of the head of the pancreas for carcinoma. Although my experience is limited, I have already encountered two cases in which such an outcome seems highly probable.

The first case is that of a 64-year-old man who had had five operations for common duct stricture, finally corrected by a Roux-Y type of repair, anastomosing the upper dilated common duct to a defunctionalized limb of jejunum. One and one-half years after his final operation he developed typical ulcer distress (relieved by milk and soda), due to a prepyloric ulcer demonstrated by x-ray examination. The symptoms were relieved by a rigid ulcer management.

The second case is one of chronic sclerosing pancreatitis in a 54-year-old woman with jaundice due to obstruction of the common bile duct. At operation the common duct obstruction was relieved by T-tube drainage of the common duct. Four months after surgery she had a massive gastrointestinal hemorrhage. Since she had received adequate doses of vitamin K and since x-ray studies of the stomach and duodenum after barium showed a rather typical deformity, it is reasonable to suspect that the hemorrhage was due to the ulcer.

From Surgical Service, Western Montana Clinic.

* References 11 and 14.

† References 12 and 13.

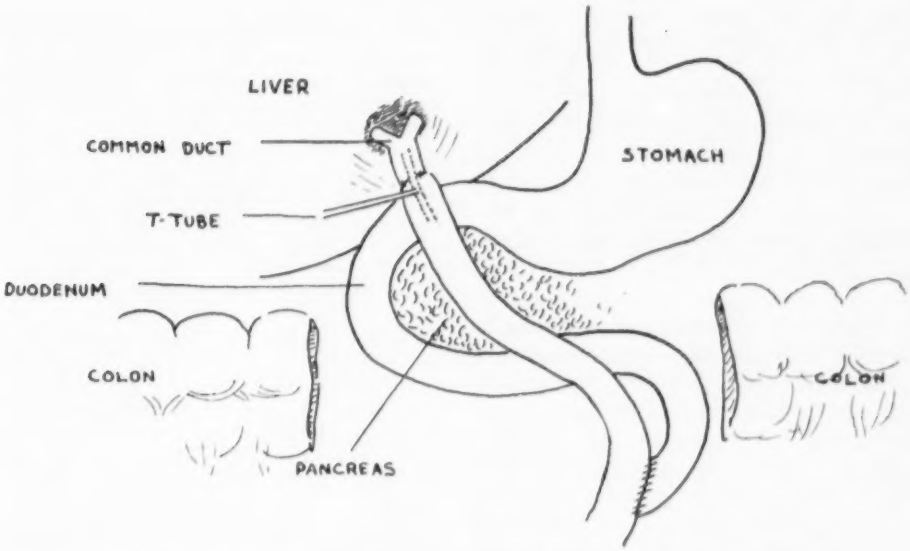


Fig. 1.—Roux-Y for strictures of common duct and chronic sclerosing pancreatitis.

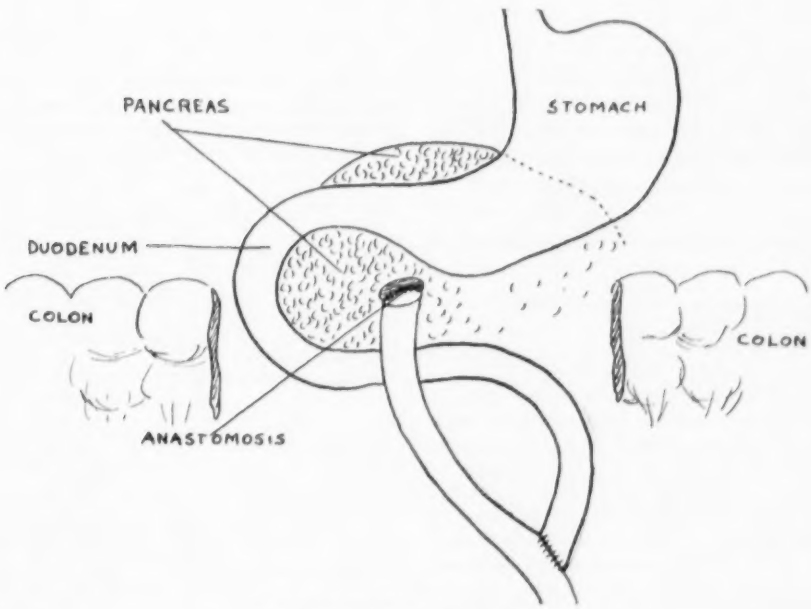


Fig. 2.—Roux-Y for pancreatic cysts.

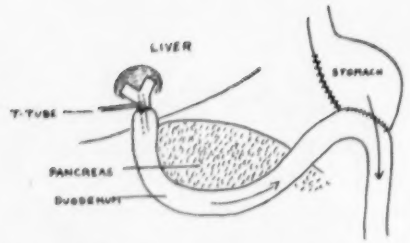


Fig. 3.—Partial gastrectomy and choledochoduodenostomy instead of Roux-Y for strictures of common duct.

Because of the theoretical objections to the Roux-Y operation, I recently described a procedure [1] which effectively accomplishes the side-tracking effect of the Roux-Y but also avoids these objections (Figs. 3 and 4). The operation consists of an anastomosis of the proximal end of the common duct to the distal end of the duodenum after transection of the duodenum below the pylorus. In case of pancreatic cyst, the anastomosis is made between the duodenum and the cyst. Partial gastrectomy is then performed and intestinal continuity restored by a posterior Hofmeister gastrojejunal anastomosis. Since I have now successfully performed various modifications of this procedure in five patients, without mortality, and since all these patients have done surprisingly well, the procedure may merit further consideration.

PARTIAL GASTRECTOMY INSTEAD OF THE ROUX-Y

CASE 1.—*Common Duct Injury During Gastric Resection for Duodenal Ulcer*[1]

The patient, a 60-year-old man, had a very difficult, active, duodenal ulcer, with penetration into the head of the pancreas. The ulcer was dissected out, and the duodenum was transected in the usual manner. It was then discovered that the ampulla of Vater entered the duodenum at the level of transection, necessitating reanastomosis of the duct into the duodenal stump. A T-tube was inserted into the common duct, the lower limb extending into the duodenum, and the cut end of the bowel was closed by inversion around the T-tube. A cholecystoduodenostomy was done as a precautionary measure. Intestinal continuity was reestablished by posterior Hofmeister gastrojejunostomy. The patient, now six years after operation, has shown no signs of recurrent common duct obstruction and is in good health.

CASE 2.—*Entrance of Common Duct Into Duodenal Diverticulum* ‡

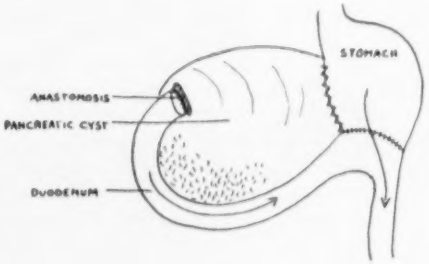
The patient, a 65-year-old woman, had recurrent bouts of mild upper abdominal distress for many months. X-ray examination revealed a large filling defect in the second portion of the duodenum thought to be either a tumor or diverticulum. Operation revealed a small duodenal ulcer and also a large duodenal diverticulum. The common duct entered the diverticulum about 2 cm. above its junction with the duodenum. After the diverticulum was removed, it was necessary to anastomose the common duct to the intestinal tract. Partial gastrectomy was performed, and an end-to-end anastomosis was made between the cut end of the duodenum and the common bile duct over a T-tube. As a precautionary measure, a cholecystoduodenostomy was also performed. Intestinal continuity was reestablished by posterior Hofmeister gastrojejunostomy. The patient, two and one-half years after operation, has remained free of symptoms, with no evidence of biliary disease.

CASE 3.—*Recurrent Postoperative Stricture of Common Duct* [1]

A 38-year-old woman had a cholecystectomy and T-tube drainage of the common bile duct in 1948. Shortly after removal of the T-tube she developed jaundice. Reoperation elsewhere revealed a stricture of the midportion of the common duct, which was repaired over a Vitallium tube. She continued to have pain and mild bouts of intermittent jaundice after this operation. Reoperation in January, 1951, revealed extensive scarring about the Vitallium tube, with dilatation of the duct above. The Vitallium tube was removed and found plugged with inspissated bile. The common duct was repaired over a T-tube; the distal limb was threaded into the duodenum after incising the ampulla to permit adequate drainage. Owing to adhesions and danger of leakage and regurgitation, a side-tracking procedure seemed advisable. The duodenum was transected and closed just above the entrance

‡ References 1 and 2.

Fig. 4.—Cystoduodenostomy and partial gastrectomy instead of the Roux-Y for pancreatic cysts.



of the common bile duct. An antral resection was done, restoring intestinal continuity by an anterior short-loop gastrojejunal anastomosis. The T-tube was removed three months later, and so far the patient has had no evidence of biliary obstruction.

CASE 4.—*Stricture of the Common Duct*

The patient is a 68-year-old woman who had been ill off and on for five years with cholecystitis and lithiasis but no jaundice. Cholecystectomy was performed elsewhere in September, 1951. After surgery she continued to have upper abdominal distress. Six months later she developed jaundice. The second operation was performed for common duct stricture in June, 1953. The duct was repaired by anastomosis over a T-tube. After a rather stormy convalescence, the jaundice cleared and the patient showed continued improvement. After removal of the T-tube six months later, the patient again developed recurring bouts of obstructive jaundice with associated chills and fever, enlargement of the liver, abdominal pain, and progressive weight loss. A third operation was performed March 15, 1954. Because of the extensive common duct stricture, end-to-end anastomosis seemed impractical. The proximal dilated portion of the duct near the portahepatis was anastomosed to the end of the duodenum after the duodenum was transected below the pylorus (Fig. 3). Partial gastrectomy was then performed, and intestinal continuity was restored by posterior Hofmeister gastrojejunal anastomosis. After surgery she made a prompt recovery, being discharged on the 12th postoperative day. The jaundice cleared, and liver enlargement subsided, and at the end of four months she was feeling well, with no appreciable difficulty.

Case 5.—*Pseudocyst of the Pancreas*

A 36-year-old woman suffered repeated mild gall-bladder attacks since 1944. She was advised to have her gall bladder removed in 1945 after discovery of gallstones. In November, 1951, she had an emergency operation for an attack of acute pancreatitis associated with fat necrosis and peritonitis. The gall bladder was evacuated of stones and drained. After recovery from this she presented herself in January, 1952, with an epigastric mass which at operation was found to be a pancreatic cyst and yielded 3 liters of fluid on aspiration. The cyst reformed, causing considerable pain, for which she took 800 to 1,000 mg. of meperidine (Demerol) for relief. She was again operated on in May, 1952, through a transverse upper abdominal incision. A large cyst of the body and tail of the pancreas, filling the lesser omental sac, was found. The small gall bladder, containing a few stones, was removed, and a T-tube was inserted into the common duct following removal of several small stones. The stomach was separated from the thickened cyst wall, and, after transection of the pylorus, the cut end of the duodenum was anastomosed to the cyst. A partial gastrectomy was then done, reestablishing intestinal continuity by posterior Hofmeister gastrojejunal anastomosis (Fig. 4). The cyst has not reformed to date.

COMMENT

It is not the intent of this presentation to suggest that partial gastrectomy be used frequently in the treatment of lesions of the common duct and pancreas. Strictures of the common duct should, whenever possible, be repaired by end-to-end anastomosis of the duct, as described by Dragstedt and Woodward [8] and Lahey and Prytek.[9] In cases of pancreatitis, sphincterotomy of the ampulla should be given primary consideration whenever possible. However, partial gastrectomy may have limited value in certain selected cases in which the Roux-Y technique would otherwise be employed. In the cases described above the outcome seemed highly satisfactory. Technical considerations were of no great difficulty. Postoperative x-ray studies failed to reveal any appreciable regurgitation of barium into the proximal duodenal loop. The procedure effectively side-tracks the intestinal current, placing the duodenum at rest, thereby minimizing the chance of leakage and abscess formation at the suture line. Bile enters the gastrointestinal tract above the gastroenterostomy, therefore minimizing the theoretical dangers of postoperative ulcer formation, a phenomenon which seems highly probable in the Roux-Y procedure.

Because lesions of this type are uncommon, it might be well in considering this procedure to recall that gastroenterostomy alone was employed as the ideal operation for duodenal ulcer for more than 15 to 20 years before the true incidence of recurrent gastrojejunal ulcerations was fully appreciated. The same may be true after the Roux-Y operation as now used in the treatment of common duct strictures and pancreatitis.

Illustrations by Miss Mary Ruth Smith, Missoula, Mont.

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CARCINOMA OF MALE BREAST

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APPROXIMATELY 1% of all carcinomas of the breast occur in males.[1] Although the disease is uncommon, the addition in recent years of various types of hormonal therapy makes it advisable to review our cases and attempt to compare the results of these newer methods of therapy with the more standard methods. For this purpose the cases at the Massachusetts General Hospital from 1914, the Collis P. Huntington Memorial Hospital from 1919, and the Pondville State Cancer Hospital have been examined. The staffs of these three hospitals overlap, and so there has been a general uniformity in the management of the cases.

MATERIAL STUDIED

Seventy-five patients were available for clinical examination. Twenty-five of these had previously received some form of definitive therapy, whereas 50 had received no treatment other than biopsy. The patients were in all stages of the disease. Sixty of the 75 patients were actually treated in our clinics, and these make up the group for end-result analysis.

GENERAL NATURE OF THE DISEASE

Carcinoma of the male breast is a disease of older men. The median age in our series for primary cases was 64 years, for the recurrent cases 62 years, and for the over-all series 63 years. This figure is distinctly higher than for similar groups of female cases.*

The interval between the onset of the initial symptoms and the time that the patient was first seen in our clinics varied greatly. One patient claimed that he had had an ulceration of the breast for 30 years, whereas two patients had their lesions discovered on routine physical examination. The median time elapsed before seeking therapy was four and one-half months.

In the vast majority of the primary cases the initial symptom was the accidental discovery of an otherwise asymptomatic breast nodule. Bleeding from the nipple, retraction, and pain were initial symptoms in each of three patients. Pain, although an uncommon initial symptom, did assume importance with extension of the local process and ulceration.

On physical examination carcinoma of the male breast generally presents a uniform picture (Fig. 1). All but two of these lesions were located beneath the nipple, and their consistency was hard. The tumor was attached to the skin and the nipple was retracted in all patients except one, with an upper outer quadrant lesion. Attachment to the underlying pectoral fascia was present in 15 of the 50 primary cases (30%). The disease was left-sided in 37, right-sided in 36, and bilateral in 2.

Thirty-six of the 50 (72%) primary cases had clinical evidence of spread to the axillary lymph nodes on initial examination. Of the remaining 14 patients, 3 had evidence of spread on examination of the specimen after radical mastectomy. Eighteen of the primary cases had evidence of spread beyond the axilla on admission.

The distribution of metastases is approximately the same for the male as for the female,[2] as shown in Table 1. In compiling

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From the Surgical Services of the Massachusetts General Hospital and the Pondville Hospital; Assistant Resident Surgeon, Massachusetts General Hospital (Dr. Huggins) and Visiting Surgeon, Massachusetts General Hospital and Pondville Hospital (Dr. Taylor).

* References 1 and 2.

this table all cases have been included. The diagnosis of metastatic disease was generally based on clinical and roentgenologic grounds.

Seven patients had or had been previously treated for cancers of other organs.

PREDISPOSING FACTORS

A search was made for the presence of antecedent premalignant lesions and factors that might predispose to carcinoma. There was no evidence that trauma played any significant role.

Fig. 1.—Typical appearance of a man with cancer of the breast.

TABLE 1.—*Metastatic Sites Seen in Our Series of Male Patients with Carcinoma of Breast*

1.	Central bony skeleton	23
2.	Lungs and pleura	16
3.	Supraclavicular lymph nodes	12
4.	Liver	7
5.	Brain	3
6.	Other	10

A strong family history of cancer (two or more cases within the patient's immediate family) was not obtained in any of our cases.

Gilbert [3] reports an incidence of gynecomastia in 19% of the patients in his series. This was present in only one of our patients, who had a history of progressive breast enlargement for 25 years before admission.

Cases of carcinoma of the male breast following estrogen therapy have been reported in the literature,† but none was encountered in our series.

† References 4 and 5.

THERAPY

Prior to the advent of orchiectomy in the treatment of cancer of the breast in the male, the prime method of therapy in favorable cases was radical surgical excision of the lesion and of the axillary lymph node-bearing areas. In the majority of our cases the Greenough technique was used.[6] This primary procedure was followed by irradiation directed at any subsequent recurrence or metastasis as it appeared. As a general policy, prophylactic postoperative irradiation was not given, except occasionally where extensive disease was present at operation.

The treatment given patients with disease outside the breast or axilla was radiation, neurosurgical procedures for pain relief, or general supportive care.

The report of Farrow and Adair,[7] in 1942, on the effects of orchiectomy in causing regression of widespread skeletal metastases in males with breast carcinoma stimulated numerous workers to investigate this form of therapy. A number of reports have appeared subsequently, of which those by Treves ‡ are the most significant. Thirteen of our patients have been treated with hormones.

As an aid in evaluating results and in formulating prognosis, all our patients have been divided into four groups according to stage of the disease:

A. Patients with disease limited to the breast or with minimal axillary lymph node enlargement (no more than two lymph nodes no greater than 2 cm. in diameter), without ulceration or fixation to the underlying pectoral fascia. In the group of secondary cases, patients with a small local recurrence following previous treatment without evidence of distant spread were included.

B. Patients with more extensive local disease than those in Stage A but without evidence of spread beyond the axilla. The same criteria applied to the secondary cases.

C. All patients with disease beyond the breast or axilla (and hence beyond all hope of cure by direct surgical attack) regardless of the local situation. The same criteria applied for the secondary cases.

D. Patients referred for terminal care.

‡ References 8 and 9.

TABLE 2.—*Distribution by Stages of Sixty Cases for Evaluation*

Stage	Primary	Secondary
A	14	2
B	12	3
C	15	11
D	1	2
	42	18

The stage designation was preceded by the numeral 1 in the primary cases and 2 in the secondary ones. The distribution of the 60 cases for evaluation is shown in Table 2.

In the 26 Stage 1A and 1B patients, there there were 26 radical mastectomies (1 bilateral) and 1 simple mastectomy. The patient treated by simple mastectomy remains without evidence of disease four and one-half years after the operation. Four of the 1B patients have subsequently received hormone therapy.

In the least favorable group, 1C and 1D, 10 patients were treated with radiation and 3 with hormones, and no specific treatment was given to 3.

In the recurrent cases radiation was given to all except six patients treated with hormones. Concomitant local excision of small areas of recurrent tumor was carried out in two.

RESULTS OF THERAPY

In evaluating the results of therapy, the schema set forth by the American College of Surgeons has been followed.[10] A total of 75 cases of carcinoma of the male breast have been seen in our clinics from 1914 to the present. Of these, 15 were seen in consultation only or refused the proffered therapy and will be omitted from end-result evaluation. Of the remaining 60 patients, 42 (70%) had received no previous therapy, whereas 18 (30%) had had some form of previous definitive therapy. No patients were seen that were treated elsewhere and were without cancer on admission or subsequently. Histologic confirmation of the diagnosis was obtained in all but four of the more advanced primary and nine of the secondary cases in which the clinical diagnosis was obvious. Follow-up to death or the present time was obtained in all except one advanced primary case.

Of the 42 primary cases, 26 died with cancer present (62%); 3 are alive with disease five years or less after treatment (7%); 8 patients either died of intercurrent disease or are living but less than five years without evidence of cancer (19%), and 5 patients are living entirely free of disease, verified by medical examination at five years (12%) (Table 3).

The results for patients with recurrent cancer are poor, 16 of the 18 patients dying with cancer (90%). One patient is alive and under hormone therapy, and one is alive one and one-half years after excision and irradiation of a small area of local recurrence from a previous radical mastectomy.

The results are better when one analyzes the most favorable primary cases, Stage 1A. All 5 of our "cures" were in this group of 14 patients who received radical mastectomy without further therapy. In the same group were four patients who died of intercurrent disease, all of whom had lived longer than two and one-half years after radical mastectomy and were without evidence of recurrence when they died. Three of the 14 patients are alive and without evidence of recurrence one and one-half, two and one-half, and four and one-half years after mastectomy. The remaining two patients died of disseminated cancer, one of whom had the only local recurrence in this group. It is

TABLE 3.—*Summary of Results**

Group			Primary Cases	Secondary Cases	Total
I	(*d*)	Living less than 5 yr. without cancer at last examination	4	1	5
II	(*e*)	Dead within 5 yr. without cancer	4	0	4
III	(*f*)	Dead—cancer present	26	16	42
	(*h*)	Living—cancer present at 5 yr.	3	1	4
IV	(*l*)	Living without cancer longer than 5 yr.	5	0	5
			42	18	60

* Summary of the results of 60 treated cases of cancer of the male breast modified from the American College of Surgeons schema.[10] Twenty-six radical mastectomies were performed in 25 of the primary cases.

evident that radical mastectomy has been of distinct value in this group of patients.

In the 12 less favorable 1B patients, all of whom had radical mastectomy, there is one patient without evidence of cancer one and one-half years later. The others either died of their disease or are being treated with hormones. Four of these patients developed local recurrence. It is evident that radical mastectomy was of little value in altering the ultimate outcome in these patients, but in two-thirds it prevented the misery of extensive local disease and was thus of some palliative benefit. Five of the 25 patients receiving radical mastectomy have been without recurrence longer than five years.

HORMONAL THERAPY

From the aforementioned schema, it is evident that all patients treated with hormones are "failures" of primary definitive therapy directed at cure. Hormone therapy has a definite role in the prolongation of useful life, and 13 of our patients have been so treated. Seven of these cases were primary cases treated initially or after recurrence. The other six were referred to us after initial treatment elsewhere.

Orchiectomy alone was used in four, and combined with diethylstilbestrol (Stilbestrol) in another six patients. Diethylstilbestrol or other estrogenic substances were used alone in three patients. Testosterone was used in two patients after the benefit from orchiectomy plus diethylstilbestrol had ceased and appeared to aggravate the disease.

An excellent result, characterized by both objective evidence of tumor regression and subjective relief of symptoms, was obtained in six patients, five of whom had orchiectomy as their initial procedure.

A good response, characterized by some evidence of tumor regression with symptomatic relief, was seen in two patients who had orchiectomy as a primary procedure.

A fair result, with some subjective relief but no objective evidence of regression, was seen in two patients who received diethylstilbestrol initially.

No benefit was seen in two patients.

The maximum duration of benefit observed occurred in one patient who is now without evidence of tumor reactivation seven years after orchiectomy. The median duration of benefit was one and three-tenth years.

In an attempt to evaluate the efficacy of hormone therapy in prolonging life, the time from the onset of initial symptoms until death (or the present time for the nine patients still living) has been plotted. Those patients not receiving hormones in addition to conventional therapy, excluding the five "cures," are shown on one curve and those treated with hormones are on the other (Fig. 2). The time from the onset of symptoms has been selected as the most uniform reference point for both groups.

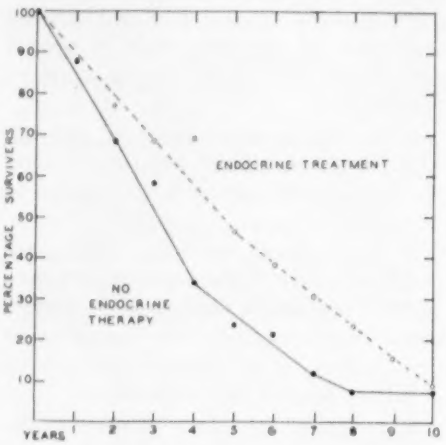

Fig. 2.—Death delay curves for the patients receiving conventional and endocrine treatment.

The median time from the initial symptom to death for those patients who did not receive hormones was three and one-tenth years, and for the patients treated with hormones four and seven-tenth years. When analyzed by the *t* test, there is a 20% possibility that this difference is due to chance, and a definitive answer awaits analysis of larger groups of patients.

COMMENT

Carcinoma of the breast in the male resembles the disease in the female in many respects, but there are also important dif-

ferences. The disease is uncommon in the relatively large series have been studied in male, making analysis of very large series of cases with follow-up impossible. A few the past, and these studies have helped point out the general nature of the disease.§

One of the more striking sex differences is seen in the average age incidence, which is about 10 years greater in the male. Other associated diseases are commoner, and other malignant conditions were seen in 7 of the 75 patients studied.

The clinical picture of breast cancer is more uniform in the male than in the female. Among the reasons for this is the smaller amount of adipose tissue and the subareolar location of the glandular tissue. The tumors are generally palpable on the most cursory examination, and, since they are associated with nipple retraction and skin fixation, there is almost no problem of differential diagnosis.

The breast lump has the same general significance in the two sexes. As is seen in Table 2, the commonest metastatic sites, other than the axillary and supraclavicular lymph nodes, are the lungs and central bony skeleton.

It is the practice in this clinic to make roentgenographic examinations of the chest and central skeletal areas, as these examinations are the most likely to demonstrate any metastases already present. If no metastases can be demonstrated, biopsy of the lesion is carried out under general anesthesia with full preparation for radical mastectomy should the lesion prove to be carcinoma on frozen section. Equipment is available for taking a split-thickness skin graft should difficulty arise in closing the skin flaps.

Histologically cancer of the breast is indistinguishable in the two sexes, and the tumors tend to metastasize to the same areas with the same frequency. It would appear that the smaller amount of insulating adipose tissue makes pectoral muscle invasion, with its consequent massaging action on the tumor, take place earlier in the male. For the same reason, skin ulceration with its attendant chronic inflammation and increased blood and lymph flow speeds tumor embolization. These factors, coupled with the general male placidity and decreased awareness of the significance of lumps in the breast, makes the disease go out of bounds for surgical cure early.

As employed at the Massachusetts General Hospital,[15] a "cure" for cancer patients consists in continuous freedom from disease five years after treatment and subsequently. Using this definition, our five-year-cure rate for primary cases was 12%, for recurrent cases 0%, and for the over-all group 8%. In the group of favorable cases—Stage 1A—there was a 35% five-year-cure rate. In the less favorable cases, radical mastectomy is of value even when done with the realization that the chance for cure is slight. In this situation the majority of patients are spared a painful, necrotic local accumulation of tumor tissue. In our experience, any operation short of radical mastectomy is attended by a very high rate of local recurrence and is inadvisable.

In general the criteria for operability (or as it should be called "potential curability" because any case is "operable" at any stage of the disease) are the same for the two sexes. None of our cases with skin ulceration or the slightest pectoral invasion was cured.

Treatment with hormones is of distinct value in prolonging useful life. In general, orchiectomy as the initial procedure has given the best results, but other combinations of agents should be tried. Bilateral adrenalectomy has been reported to have given good results in two patients when more standard therapy had failed to produce continued remission.‖

Although treatment with hormones has given some excellent results, 2 of our 13 patients received no benefit, and thus it should not replace radical mastectomy as the first line of defense in favorable cases of carcinoma of the male breast.

§ References 3, 11, 12, and 13.

‖ References 16 and 17.

SUMMARY AND CONCLUSIONS

An analysis of 75 cases of carcinoma of the male breast has been presented and certain general conclusions drawn:

1. The clinical appearance of the lesions is quite typical and the significance of the breast lump is the same in the male as in the female.

2. The disease tends to get out of bounds for surgical cure early in the male owing to pectoral invasion and skin ulceration. The corollary obtains that early vigorous surgical treatment is required to cure the man with breast cancer.

3. Eight per cent 5-year cures were obtained for the over-all group of patients, but this figure rose to 35% for the most favorable ones.

4. The classic radical mastectomy remains the treatment of choice for all patients with favorable and borderline lesions. Hormonal and radiation therapy are of value for palliation in less favorable cases.

5. Orchiectomy as an initial procedure offers the best chance for palliation of patients with disseminated disease.

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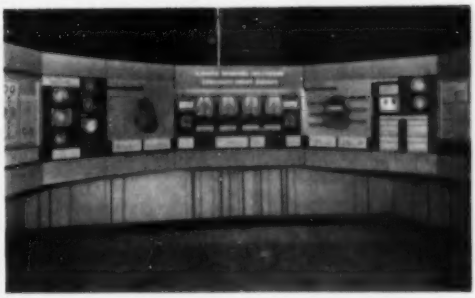
Scientific Exhibits



A SIMPLE OPERATION FOR THE TREATMENT OF CHRONIC CORONARY ARTERY DISEASE

M. S. MAZEL, M.D.; MAX M. BERNSTEIN, M.D.; IRWIN R. CALLEN, M.D.
IRA L. SCHNAER, M.D.; L. T. WU, M.D.; ALFRED BONK, M.D.
CHICAGO

For the past 4 years we have been doing coronary ligation and cardiopericardiopexy in the dog; and to date we have performed the Thompson operation in 47 patients.

INDICATIONS:

1. Angina on effort and definite evidence of coronary artery disease as confirmed by clinical and laboratory findings.
2. Coronary artery disease after recovering from an acute infarction (3 to 6 months).
3. Any chronic coronary heart disease showing no improvement following medical management.

CONTRAINDICATIONS:

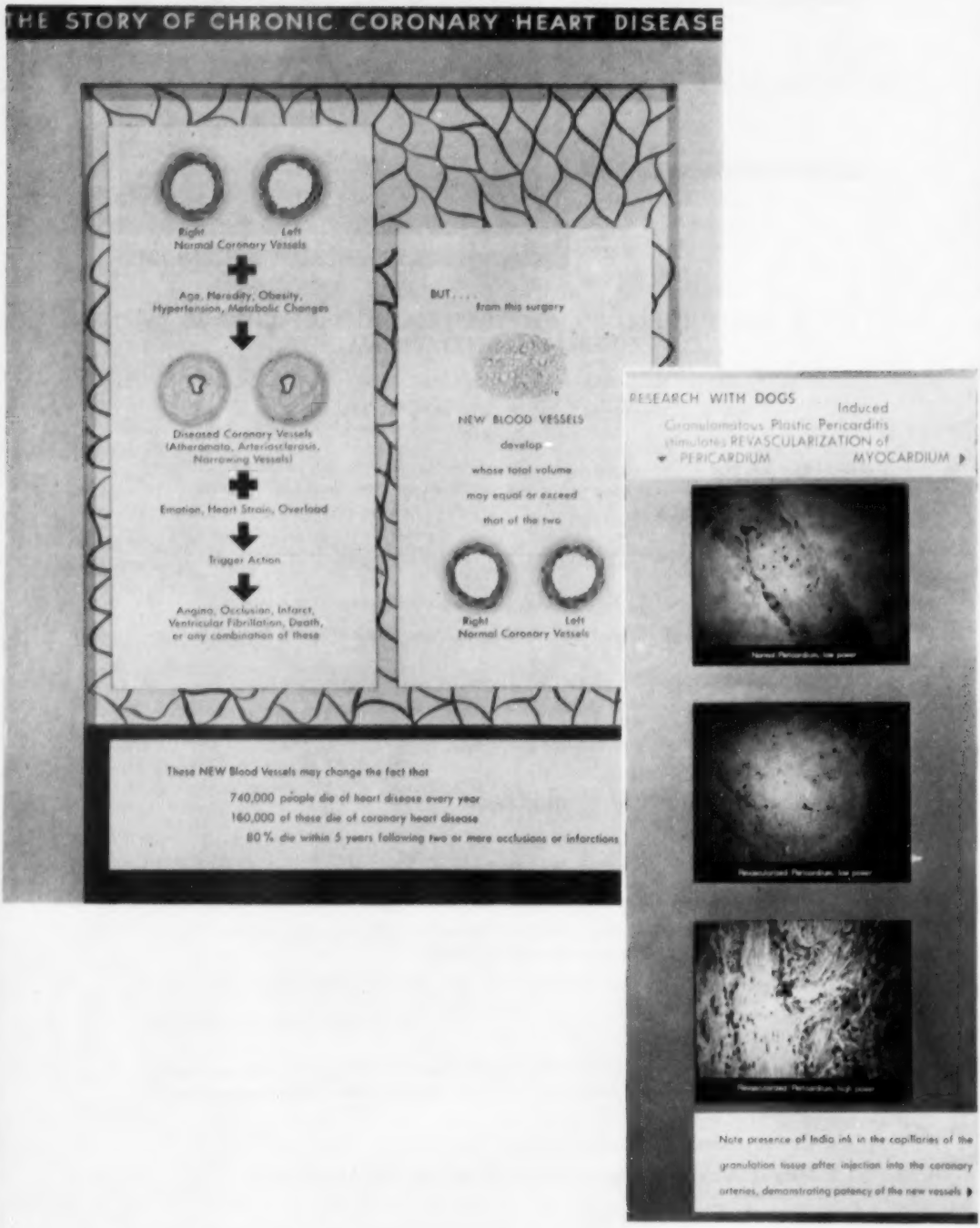
1. Congestive failure.
2. Active myocardial infarct or occlusion.
3. Severe liver or kidney damage.

CRITERIA FOR SURGICAL CANDIDATES:

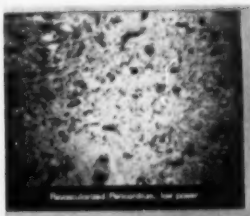
1. Age—up to 67 years.
2. Positive proof of coronary artery insufficiency.
   a. If angina—do EKG and positive Masters exercise test.
   b. If history of infarction, do only EKG. Do not do Masters exercise test, but wait 3 to 6 months for healing before considering surgery.
3. EKG readings on three alternating days must show definite stabilized pattern.
4. Sedimentation rate and white count must be normal on three alternating days, unless due to other causes.
5. No case should be done without an associate Internist or Cardiologist to rule out an active infarction, which is main danger, and to follow whatever future medical management is necessary.
6. Time to operate is early, before infarction.
7. Many cases, even following infarction, can be salvaged (after 3 to 6 months).

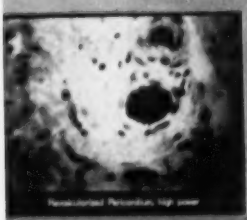
From the Edgewater Hospital.

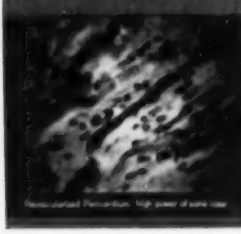
Shown as a scientific exhibit of the Section on Diseases of the Chest at the 103rd Annual Meeting of the American Medical Association, San Francisco, June 21-25, 1954.


THE STORY OF CHRONIC CORONARY HEART DISEASE
Right
Left
Normal Coronary Vessels
Age, Heredity, Obesity, Hypertension, Metabolic Changes
Diseased Coronary Vessels (Atheromata, Arteriosclerosis, Narrowing Vessels)
Emotion, Heart Strain, Overload
Trigger Action
Angina, Occlusion, Infarct, Ventricular Fibrillation, Death, or any combination of these
BUT . . . from this surgery
NEW BLOOD VESSELS develop whose total volume may equal or exceed that of the two
Right
Left
Normal Coronary Vessels
These NEW Blood Vessels may change the fact that
740,000 people die of heart disease every year
160,000 of these die of coronary heart disease
80% die within 5 years following two or more occlusions or infarctions
RESEARCH WITH DOGS
Induced
Granulomatous Plastic Pericarditis
stimulates REVASCULARIZATION of
PERICARDIUM
MYOCARDIUM
Note presence of India ink in the capillaries of the granulation tissue after injection into the coronary arteries, demonstrating patency of the new vessels

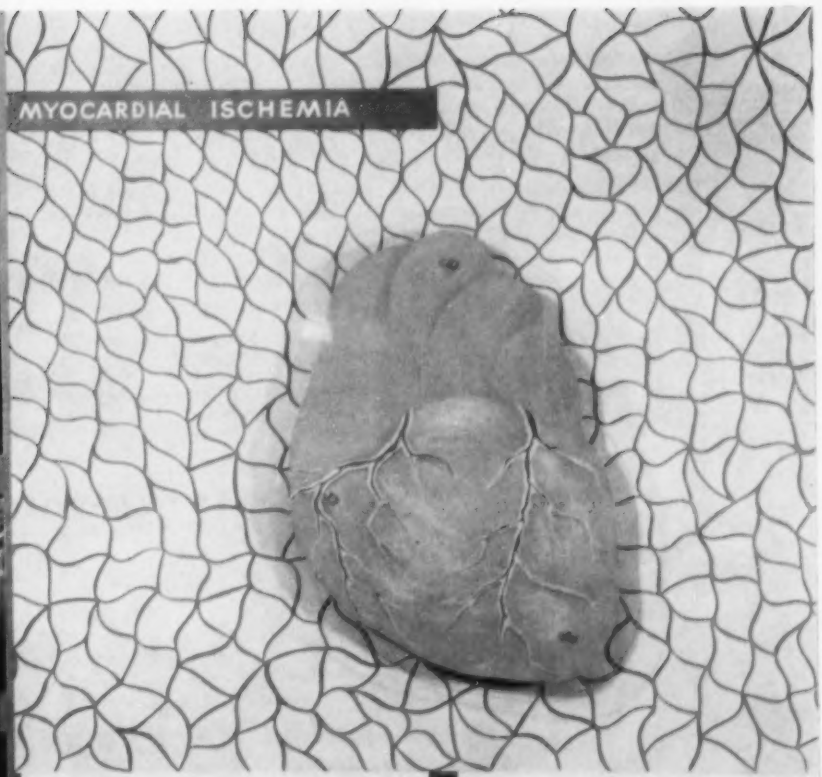
OPERATION FOR CORONARY ARTERY DISEASE







MYOCARDIAL ISCHEMIA



PRE-OPERATIVE CARE

1. Penicillin daily and neo-penil 500,000 units daily for 3 days
2. Serial EKG every other day for 3 days
3. Blood studies every other day for 3 days
4. Sedimentation rates every other day for 3 days

5. Alertness to an active coronary infarction
6. X-ray of the heart, lungs, etc., to rule out other diseases simulating angina or coronary heart disease
7. Use of digitalis or quinidine as indicated in certain cases

TECHNIQUE OF SURGERY

Patient put to sleep in room with Pentothal Sodium and supplemented with local anesthesia. 4½ inch incision beginning at margin of sternum of left 5th rib, removing about 2½ inches of cartilage giving access to free space without entering pleural cavity. After opening pericardium, fluid is aspirated with soft rubber catheter until almost dry (very important).

About 1½ to 2 drams by volume of USP Talc powder is spread over heart and blown with atomizer until myocardium is covered with thin white layer so that it reaches base, apex, lateral and posterior portions of the heart. *Do not depend on heart action alone to distribute powder.* Pericardium closed loosely and wound closed in layers without drainage.

Patient is given oxygen from the time he is put to sleep in the room, as well as on the cart to and from the operating room, and after surgery is placed in an oxygen tent or given nasal oxygen for 24 to 48 hours. Blood pressure maintained at same pressure as it was before surgery by Levophed given intravenously slowly or other drugs. Dangle that evening. Up and about following day and maintained on Digitalis or Quinidine as directed by Internist. Discharged from hospital one week to ten days following surgery.

RESULTS

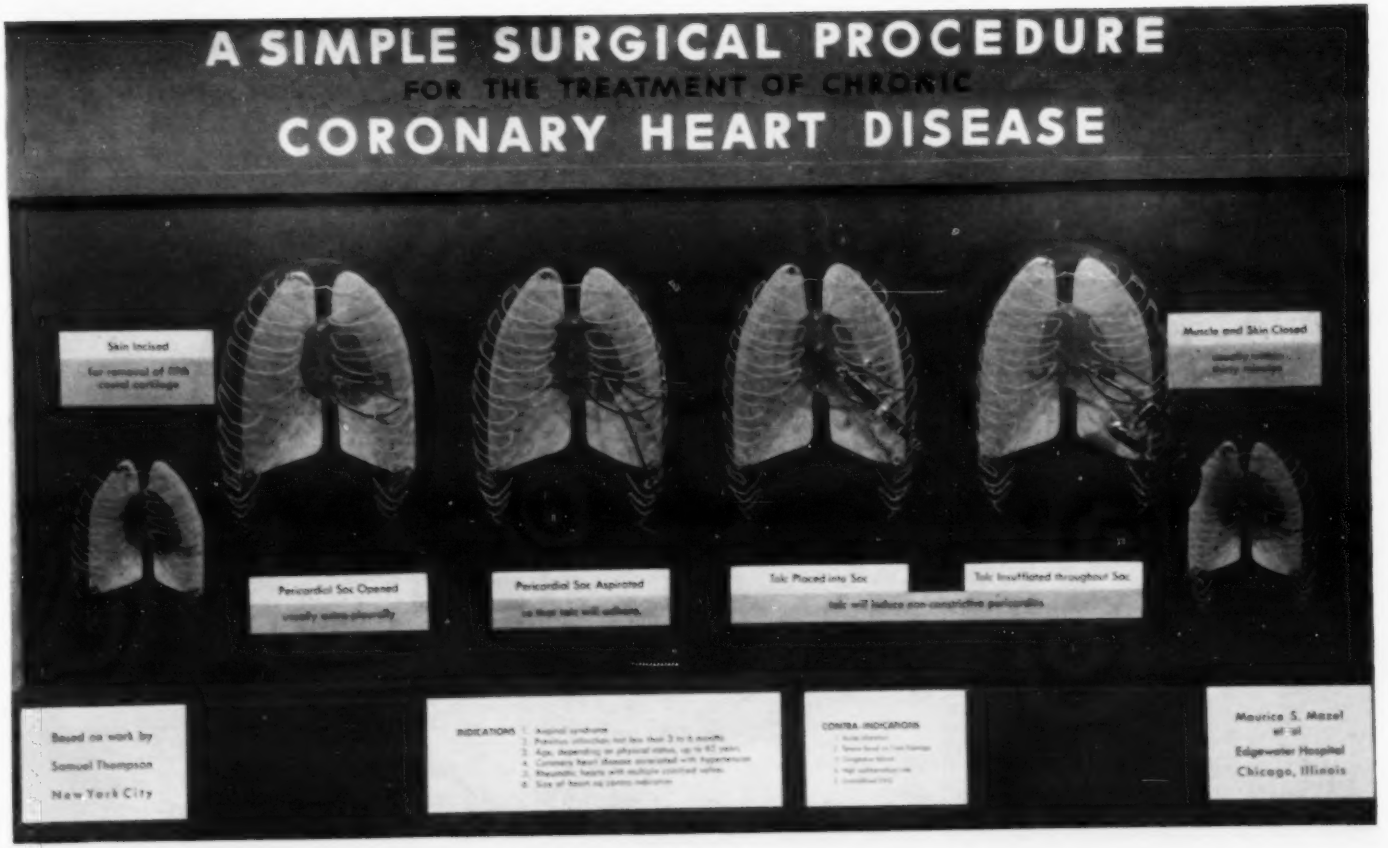
The USP Talc produces a non-constrictive granulomatous pericarditis. This lesion hastens the development of inter-coronary and extra-coronary anastomosis. This operation attempts to accomplish in 30 minutes, that which nature and medical management attempts to do in months or years. It is my opinion that the USP Talc and its application is superior to Nitroglycerin, Peritrates, Dicumarol, Heparin and other drugs.

Most patients successfully revascularized we feel have been protected against further myocardial insults. Most of them have been rehabilitated, returned to work, discarded their drugs and lived like normal human beings.

OPERATIVE ORDERS FOR PATIENTS UNDERGOING CARDIAC SURGERY

1. While patient is undergoing study he must be taught to breathe deeply at least ten times every hour during the day and continued after surgery.
2. Dicrysticin daily for three days prior to surgery unless patient is allergic to antibiotics.
3. On alternating days do serial E. K. G. examinations to rule out active process.
4. Daily sedimentation rates.
5. Daily white and red and hemoglobin determination. Measure fluid intake and output for 24 hours.
6. Rule out following:
   - Gall Bladder Disease
   - Peptic Ulcer
   - Hiatus Hernia
   - Diverticulum of Stomach and Esophagus
   - Evidence of congestive failure
   - Bursitis of shoulder and Arthritis of neck
7. Rule out if patient is allergic to Penicillin and other antibiotics.
8. Blood pressure readings daily for 3 days before surgery.
9. Complete physical examination—especially heart, lungs, liver, spleen and ankle edema.
10. Blood chemistry—urea, blood sugar, Kahn and cholesterol.
11. Complete urine.

A SIMPLE SURGICAL PROCEDURE
FOR THE TREATMENT OF CHRONIC
CORONARY HEART DISEASE



Based on work by
Samuel Thompson
New York City

Maurice S. Mazel
et al
Edgewater Hospital
Chicago, Illinois

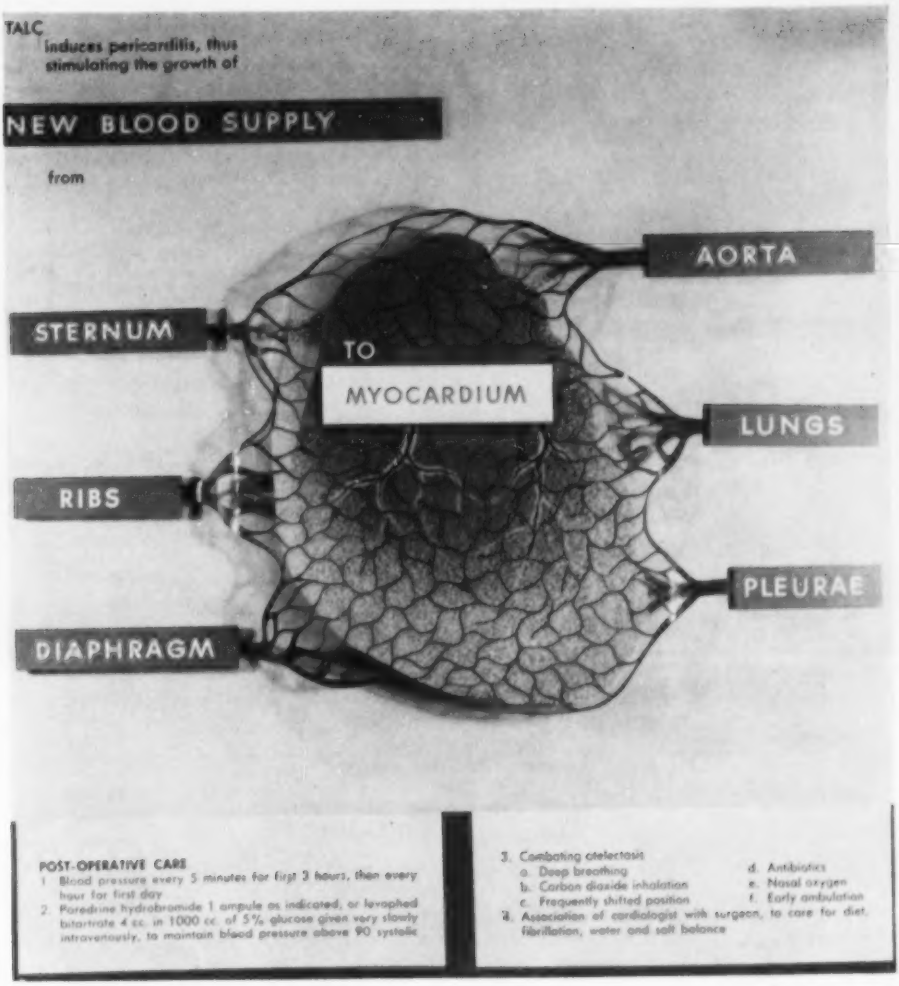
PRE-OPERATIVE ORDERS

1. One vial Neo Penil (500,000 units) each day for 3 days before surgery.
2. X-ray chest before leaving O.R. to make certain pleura has not been entered. If so, remove air by suction or set up with closed catheter and bottle until lung expands.
3. Patients know they are going to surgery, but exact time is not revealed, as they are put to sleep in room with Sodium Pentothal.
4. M.S. gr. 1/6 } ½ hour before surgery.
   Atropine gr. 1/150 }
5. Patients are encouraged by the nurse in attendance. All apprehension must be allayed, and no discussion of temperature, pulse rate, drop or rise in blood pressure must be discussed in the presence, or hearing, of the patient. All records must be charted and any unusual or alarming symptoms should be called to the attention of the surgeon outside of the room.
6. Carts bringing patient to and from operating room must be equipped with oxygen, and the patient must be given "O" during transportation.
7. Patients do best by complete digitalization day before surgery.

POST-OPERATIVE ORDERS

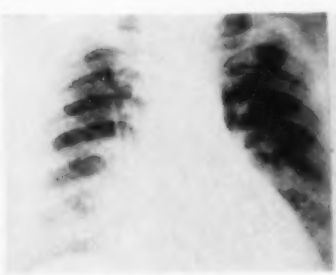
As soon as the patient awakens after surgery, give CO_2 95% one inch away from the nose for one minute every hour for the first 24 hours. Later three times a day until the patient can breath deeply by himself.

1. Patients must not be allowed to suffer pain. They should be given M.S. gr. 1/6 or 1/3 Pantopon q. 4 hr. as necessary for their comfort. Give 1/6 M.S. before leaving surgery. In addition, if necessary give slowly intravenously in surgery.
2. A near sitting position is preferable, but if patient is more comfortable he may be allowed to recline.
3. As soon as he awakens he is encouraged by the nurse as to his excellent condition and made to breathe deeply ten times every hour during waking hours and encouraged to cough and blow balloons even though he has pain over the incision (this pain is not heart pain but due to the incision, sutures and mediastinitis.) This should be explained to the patient before and after the surgery, so he is aware of the pain and so he does not feel it is a recurrence of his old condition.
4. Measure intake and output of urine—if less than 300 cc. urine in 24 hours, give ampule of Mercuhydrin or Thiomerin as necessary, and give 1000 cc. glucose of 5 or 10% intravenously.
5. **OXYGEN** is given for about 24 to 48 hours depending on the condition of the patient either in the tent (preferably) or nasal catheter, about 12 liters per minute and later reduced to 8 or 10 liters. The patient should wear a pneumonia jacket and a cap in the oxygen tent if it is cool.
6. **BLOOD PRESSURE,** pulse and respiration readings are taken and recorded every three minutes following surgery for the first 3 hours, later every hour and 3 times a day after 24 hours. If blood pressure falls below 90 systolic, give 10mgs. of Paredrine intramuscularly. If pressure continues to drop to 80, notify surgeon immediately and give 5 mg. (or ½ ampule Paredrine very slowly) intravenously, and add one vial, or 10 mg., to intravenous solution which will maintain blood pressure level, or use Levophed—4 cc. in 1000 cc. 5% Dextrose solution—by very slow drip—4 to 10 drops per minute for the first 3 hours or longer to maintain satisfactory blood pressure after surgery.

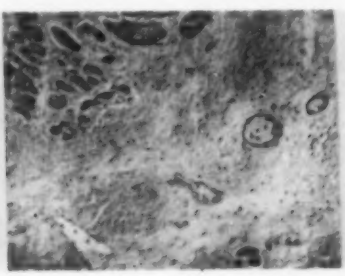

TALC
induces pericarditis, thus stimulating the growth of
NEW BLOOD SUPPLY
from
AORTA
STERNUM
TO
MYOCARDIUM
LUNGS
RIBS
PLEURAE
DIAPHRAGM
POST-OPERATIVE CARE
1. Blood pressure every 5 minutes for first 3 hours, then every hour for first day
2. Paredrine hydrobromide 1 ampule as indicated, or levophed bitartrate 4 cc. in 1000 cc. of 5% glucose given very slowly intravenously, to maintain blood pressure above 90 systolic
3. Combating atelectasis
a. Deep breathing
b. Carbon dioxide inhalation
c. Frequently shifted position
d. Antibiotics
e. Nasal oxygen
f. Early ambulation
4. Association of cardiologist with surgeon, to care for diet, fibrillation, water and salt balance

RESULTS WITH HUMANS

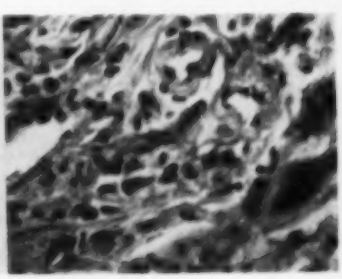
47 cases, with moderate to marked disability, operated on during two years at Edgewater Hospital are all alive and working except 3 with two surgical mortalities.



Mediastinal reaction following surgery.



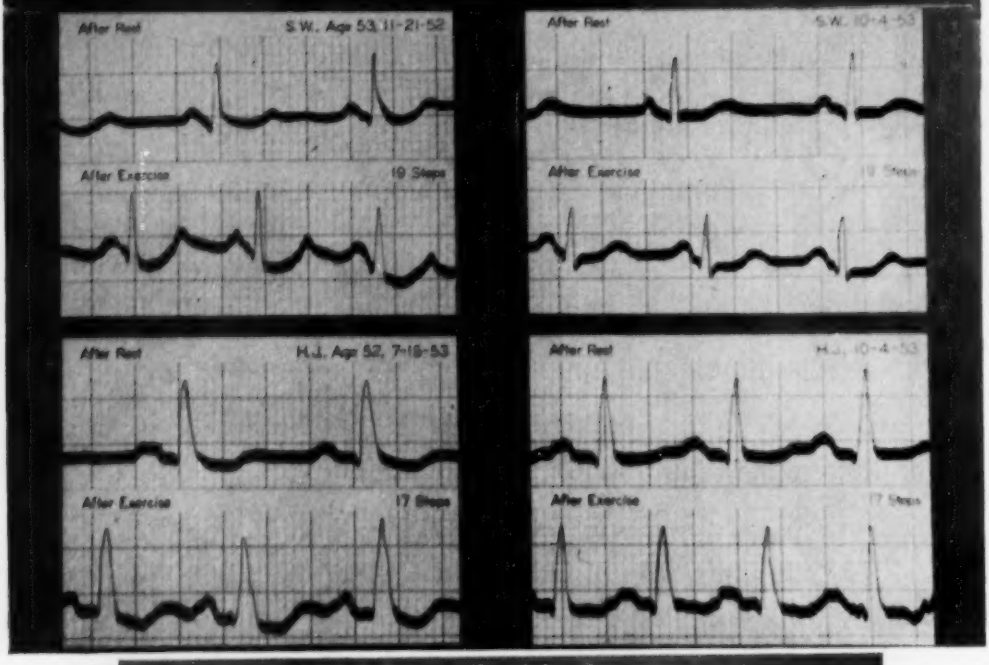
Revascularization of a myocardial infarct.



Persistence of newly formed capillaries in the granulation tissue after 15 months.

MASTER EXERCISE TEST

Before Surgery — Lead 2 — After Surgery



ADVANTAGES of this treatment

1. It is simple to perform
2. It requires about 30 minutes
3. It can be done under local and pentothal sodium anesthesia
4. It can usually be done extra-pleurally

5. Its mortality is almost nil when cases are screened as described
6. It gives symptomatic and clinical relief in myocardial ischemia caused by rheumatic as well as coronary heart disease

7. The USP talc produces a non-constrictive granulomatous pericarditis which is permanent
8. The granulomata, proven unchanged at autopsy ten years later, are considered permanent

THE HEART IS PROTECTED

7. Patient should dangle the evening of the operation and void by himself if possible. If unable, catheterize patient. The following day he may be allowed to go to the bathroom with assistance to void and can walk around the room several times during the day and later returned to tent or use of nasal oxygen if necessary.

DIET

At first water (sips) and ice chips. If tolerated well, the patient may be given surgical liquids. If nasal oxygen is used—shut off oxygen while eating or drinking. (Danger of dilating stomach.)

The following day he may have bland diet.

3rd day he can have a light or general diet—Special Cardiac Low Salt Diet for cardiac surgical patients. See dietitian. (*No gas* forming foods.)

BOWELS

If distention occurs, use rectal tube and siphon enemas. 3rd post-operative day may give S.S. enema and 1:2000 Prostigmin if necessary.
Milk of Magnesia oz. 1 } may be given after the 2nd post-operative day to keep bowels
Aromatic Cascara Dram 1 } open and prevent distention.

Patient may be up and about freely on the 3rd post-operative day providing there are no complications.

Antibiotics are given as follows:
Dicrysticin, 400,000 twice daily until temperature is normal for 3 days.
If patient is allergic, use non-allergic penicillin 100,000 initial dose in combination with Terramycin 500 mg. at initial dose and later 250 mg. q. 4 hrs.

DRUGS

Pantopon gr. ⅓ or M.S. gr. ⅙ for first 24 hours only—Nitroglycerin if necessary. Quinidine, gr. iii should be given 3 times a day following surgery if tolerated or Digitoxin .2 mg. as ordered by surgeon or attending cardiologist.

X-RAYS OF CHEST AND EKG (NOT portable), red and white counts should be done at least every 3 to 4 days following surgery until patient is discharged.

TEMPERATURE

Recorded q. 3 hr. and in elderly patients rectal temperature should be recorded.

Most drugs can be discontinued after first 48 hours. If nauseated, give Dramamine per hypo and stop Digitalis, M.S. or Pantopon—check dilated stomach.

Patient usually leaves the hospital in one week or ten days following surgery, and is turned over to internist or cardiologist.

FROM "BENIGN" POLYP TO CARCINOMA

BENEDICT R. WALSKE, M.D.
JAMES W. HAMILTON, M.D.
AND
PAUL KISNER, M.D.
LINCOLN, NEB.

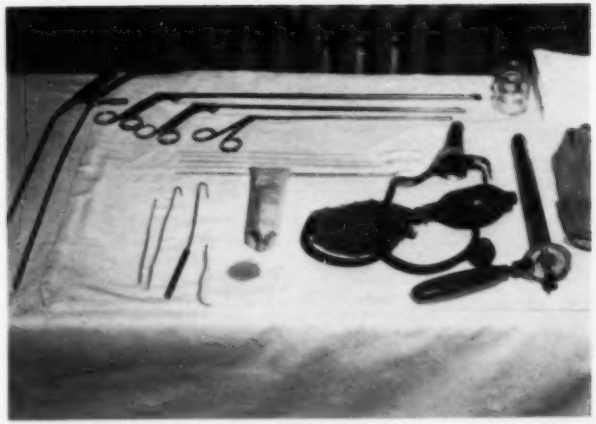
POLYPS of the colon are among the commonest of neoplasms in man. They are most frequently associated with only vague symptoms or no symptoms at all, resulting much too often in neglect of the problem by patient and physician alike. The purpose of this exhibit is to emphasize the frequency of malignant degeneration and the importance of early diagnosis and eradication of polyps of the colon.

This exhibit represents a study of 1,000 male patients admitted for all causes and examined by proctosigmoidoscopy and barium enema roentgenography. The incidence of polyps in this series of hospital patients is about 15%, or approximately twice that of cancer survey centers among consecutive patients of both sexes; yet one cannot fail to be impressed by its frequency.

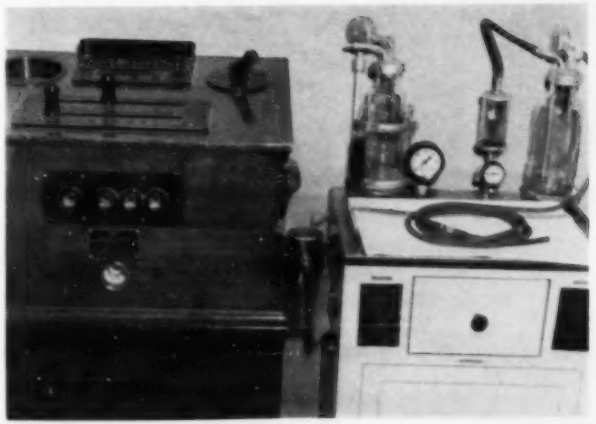
From the Veterans Administration Hospital.

Shown as a scientific exhibit of the Section on Gastroenterology and Proctology at the 103rd Annual Meeting of the American Medical Association, San Francisco, June 21-25, 1954.

DIAGNOSTIC AND THERAPEUTIC EQUIPMENT FOR PROCTOSIGMOIDOSCOPY



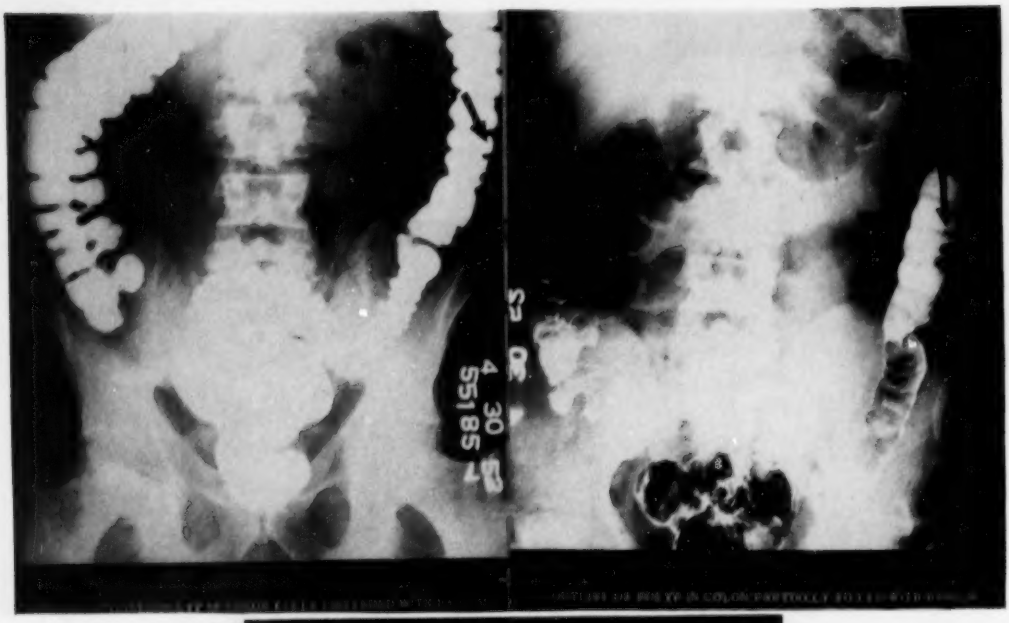
Equipment and materials commonly used in proctosigmoidoscopy.



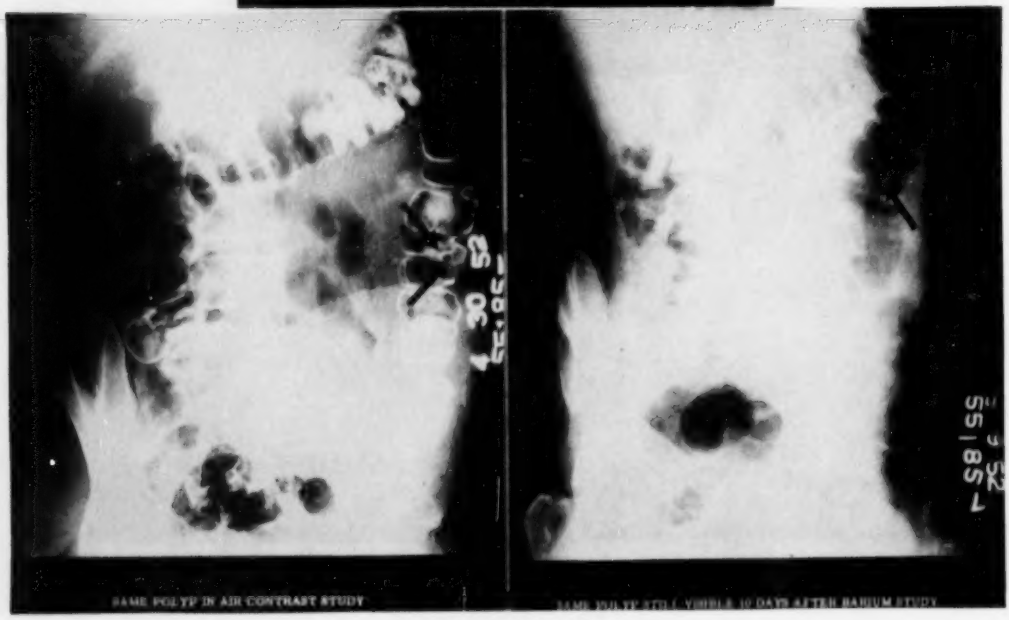
Some source of suction and fulgurating current is recommended.

A flat surface and knee-chest position is adequate for proctosigmoidoscopy.

A special proctoscopic table is not essential but adds to comfort of patient.



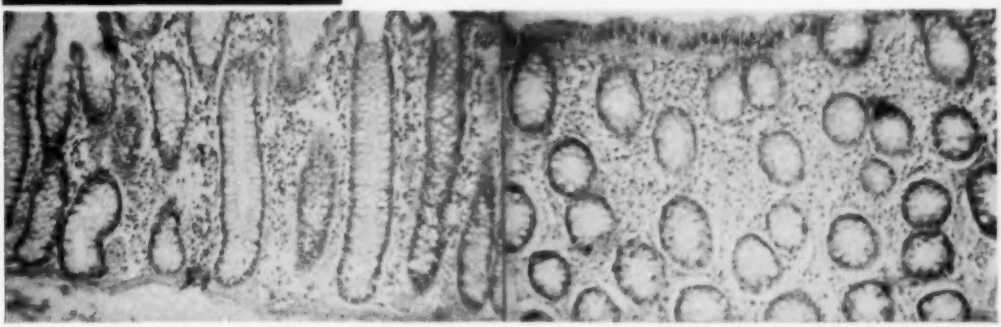
On the basis of our studies it is our opinion that most carcinomas of the colon originate within polyps. Varying degrees of degeneration of polyps within the same colon have been repeatedly demonstrated.



BARIUM ENEMA STUDIES

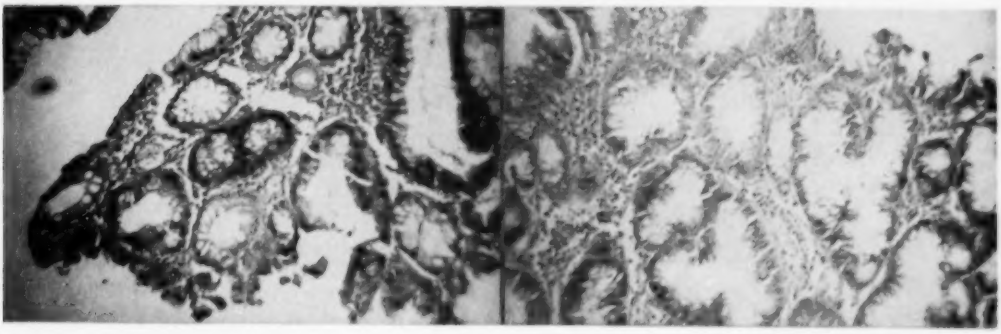
1000 CONSECUTIVE ROUTINE PROCTOSIGMOIDOSCOPIES ON MALE PATIENTS HOSPITALIZED FOR ALL CAUSES		
TOTAL POLYPOID LESIONS	151	(15%)
Youngest patient	21 years	
Oldest patient	82 years	
Average age	53 years	
BENIGN POLYPOID LESIONS	81	(54%)
MALIGNANT POLYPOID LESIONS	70	(46%)
Grade I	25	(16%)
Grade II	11	(7%)
Grade III	19	(13%)
Grade IV	15	(10%)

TRANSITION FROM BENIGN POLYP TO CARCINOMA



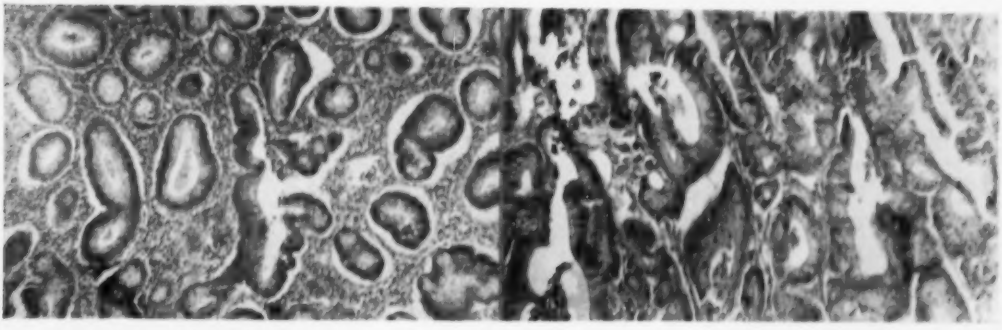
Normal colon mucosa

Adenomatous polyp, benign



Polyp, Grade I carcinoma

Polyp, Grade II carcinoma



Polyp, Grade III carcinoma

Polyp, Grade IV carcinoma

RECOMMENDED TREATMENT

I. Adenomatous polyp, benign or with grade I changes:

a. Proctoscopic or transcolonic excision and fulguration of base

b. Colectomy in presence of multiple and widely spread polyps

II. Polyps of grade II and above:

a. Radical resection by abdomino-perineal or anterior routes

PREVENTIVE MEDICINE
IN NEOPLASTIC DISEASES OF THE COLON

POLYPS OF THE COLON - A PUBLIC HEALTH PROBLEM

Carcinoma of the colon is usually preceded by a polyp

In 1957 (U.S.) estimated:
Carcinoma of the colon 18,000
Pulmonary Tuberculosis 18,000
Infantile Paralysis 1,700

Polyps of colon a serious problem demanding [illegible] dissemination of facts

Carcinoma of the colon with [illegible] largely preventable by proper attention to polyps

95% of polyps and carcinomas of colon are within reach of the proctosigmoidoscope

6. RECOMMENDED PROGRAM

a. Annual proctosigmoidoscopy for persons over 40 years of age

b. Semiannual proctosigmoidoscopy and air-contrast barium enema X-ray study for cases with familial history or previous diagnosis of polyps regardless of age

c. Proctosigmoidoscopy and air-contrast barium X-ray study for all persons with lower bowel symptoms with repeat of study in 6 months if negative

less handling
ties faster
no winding–no waste

allows twice
as many ties
per suture

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1. Grogan, E.A.: Radiology, 41:455, Oct., 1943.
2. Everett, E.F., and Rigler, L.G.: Radiology, 39:334, Apr., 1942.

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